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# APPENDIX E: DOCUMENTATION OF ESTIMATED COSTS

As part of its assessment of actions to remove the Chesapeake Bay and its tidal tributaries from the list of impaired waters under the Clean Water Act, U.S. EPA's Chesapeake Bay Program (CBP) Office estimated the costs and nutrient (nitrogen and phosphorus) reduction potential of nutrient removal technology and best management practices under several alternative scenarios. This appendix summarizes the purposes, methods, and results of the cost assessment. Note that sediment reduction is not specifically addressed, unless it is included in the removal practices. Control of air sources is also not addressed in the scenarios.

## 1. BACKGROUND AND OBJECTIVES

The CBP developed tiered implementation scenarios of nutrient reduction measures for the Chesapeake Bay watershed based on the extent of controls already in place as of the year 2000 (the 2000 Progress scenario), and estimates of the controls that would be in place if current implementation rates were continued through the year 2010 (the Tier 1 scenario). Then, the Tier 2, 3, and 4 (which represents a theoretical limit of technology, but may not be achievable) scenarios add incremental increases in implementation levels. The tier scenarios, developed by various stakeholder workgroups, are based on the CBP's estimates of 2010 populations and land uses in the basin. Since Tier 4 may not be feasible, this report provides estimates of the cost of Tiers 1, 2, and 3. Note that these cost estimates reflect, in part, the extent of efforts to date which vary across States. However, State data on controls in place throughout the watershed are incomplete, which may result in overestimates of costs for the tiers.

This appendix provides estimates of the total annual cost of achieving the tier scenarios, total capital cost requirements, and, to the extent that information could be compiled, estimates of how these costs may be shared between the public and private sectors. For example, the CBP assumed that current agricultural cost-share and incentive payments are continued (i.e., there are no limits in program funding). Similarly, it assumed that the States of Maryland, and Virginia to a lesser extent, would provide grants to assist in funding nutrient reduction technologies for publicly owned treatment works. Costs for the remaining practices specified in the tier scenarios are attributed to the private sector (although public programs could be used to fund these controls as well).

In addition to summarizing the resources required for each level of control implementation, the cost estimates can also be used to investigate the potential economic impacts of the scenarios. The Use Attainability Analysis (UAA) Workgroup used these estimates to develop screening-level impact analyses based on the same assumptions described above regarding how costs may be shared between the public and private sectors (see Appendix H). U.S. EPA also used the estimates in a regional economic impact analysis for the UAA Workgroup. Finally, the cost assessment provides data for analysis of the cost-effectiveness of the tier scenarios in achieving the target water quality objectives.

This appendix is organized as follows. Section 2 describes the methods for estimating the cost of nutrient reduction technologies for point sources and best management practices (BMPs) for nutrient control. Section 3 summarizes results, including capital and total annual costs, by political and hydrogeologic boundaries.

## 2. METHODS

The sections below describe the methods for estimating the costs of the tier scenarios for POTW and industrial sources (Section 2.1) and agriculture, forestry, urban, and onsite waste management system sources (Section 2.2).

## 2.1 POTWs and Industrial Sources

The CBP convened a multi-stakeholder Nutrient Removal Technology (NRT) Task Force to develop point source costs for the tier scenarios. The Task Force's method and estimated costs are described in detail under separate cover (NRT Cost Task Force, 2002), and summarized in this appendix.

The NRT Task Force developed costs for significant municipal and industrial facilities located in the watershed that discharge nitrogen and phosphorus. Significant municipal facilities are generally defined as wastewater treatment plants that discharge flows of 0.5 million gallons per day (mgd) or greater, although the threshold may vary slightly from jurisdiction to jurisdiction. Significant industrial facilities are those discharging nutrient loadings greater than or equal to those discharged by a municipal wastewater treatment with a flow capacity of 0.5 mgd, which equates to approximately 75 lbs/day of total nitrogen (TN) and 25 lbs/day total phosphorus (TP) based on a municipal discharge of 18 mg/L TN and 6 mg/l TP.

### 2.1.1 Point Source Nutrient Reduction Scenarios

The tier scenarios incorporate varying levels of nutrient reductions for point sources. For municipal facilities, Tier 1 includes current or planned pollutant controls; Tier 2 requires end-of-pipe effluent concentrations of 8.0 mg/L TN, and either 1.0 mg/L TP or the permit limit (whichever is lower); and Tier 3 requires end-of-pipe effluent concentrations of 5.0 mg/L TN, and the lower of 0.5 mg/L TP or the permit limit. For industrial facilities, Tier 1 represents no change from current levels, and the effluent concentrations required for Tiers 2 and 3 generally correspond to those of municipal facilities. **Exhibit E-1** provides a summary of the tier scenarios for municipal and industrial facilities.

**Exhibit E-1: Scenarios of Nutrient Reduction for Point Sources**

| Source | Tier 1 | Tier 2 | Tier 3 |
|---|---|---|---|
| Significant Municipal Wastewater Treatment Facilities (as of 2000) | Existing NRT facilities and those planned to go to NRT by 2010: 2010 flow with 8.0 mg/L TN effluent concentration and year 2000 concentrations ofTP. For all remaining facilities: 2010 flow with year 2000 TN and TP concentrations. | Reach and maintain 8.0 mg/L TN and 1.0 mg/L TP effluent concentrations at 2010 flows at all facilities. (Phosphorus concentration is 1.0 mg/L or permit limit, whichever is more stringent.) | Reach and maintain 5.0 mg/L TN and 0.5 mg/L TP effluent concentrations at 2010 flows at all facilities. (Phosphorus concentration is 0.5 mg/L or permit limit, whichever is more stringent.) |
| Significant Industrial Wastewater Treatment Facilities (as of 2000) | Maintain current levels or permit conditions if less. | Generally a 50% reduction from Tier 1, or 2000 concentrations or permit conditions if less. | Generally a 80% reduction from Tier 1, or 2000 concentrations or permit conditions if less. |
| Non-significant Municipal Wastewater Treatment Facilities (as of 2000) | Maintain current TN/TP concentrations with 2010 flows. | Maintain current TN/TP concentrations with 2010 flows. | Maintain current TN/TP concentrations with 2010 flows. |
| Combined Sewer Overflow (CSO) (District of Columbia only) | 43% reduction in CSO. | 43% reduction in CSO. | 43% reduction in CSO. |

Note that for municipal facilities, TN and TP concentrations may increase from one tier to the next. For example, concentrations for some facilities increase between 2000 Progress and Tier 1 because the NRT Task Force believes that some facilities may not be able to operate as efficiently at 2010 flows as they do at 2000 flows and, therefore, the 2000 concentration may not be representative of 2010 conditions. For facilities with TN concentrations less than 8 mg/L in 2000, the Task Force assumed concentrations would increase to 8 mg/L by 2010. The same principle is true for TP (i.e., the Task Force assumed concentrations would increase to 1 mg/L by 2010 if the 2000 concentration is less than 1 mg/L).

### 2.1.2 Overview of Method

The NRT Task Force developed costs for controlling nitrogen and phosphorous separately using estimates obtained directly from affected facilities, where available, and applying the methods described below if facilities did not provide estimates. However, for Tier 1, which represents current or planned controls, costs are zero for municipal facilities that did not provide costs. There are also no costs for industrial facilities under Tier 1, since it represents no change from 2000 effluent concentrations. Finally, costs currently include upgrades for several State-owned and Federal facilities. Households in the watershed will not incur direct costs for these facilities and, therefore, efforts are being made to identify all of these facilities and exclude them from future analyses.

The NRT Task Force developed estimates for capital and annual operating and maintenance (O&M) costs. This appendix also provides these estimates annualized over 20 years. For municipal facilities, the annualized estimates reflect an average 2001 Statewide Revolving Fund rate for each State (1.0% for DE, 2.2% for MD, 2.5% for NY, 2.5% for PA, 3.9% for VA, and

0.7% for WV) and the national average rate of 2.4% (EPA, 2001d) for the District of Columbia. For industrial facilities, the annualized estimates reflect a 5.76% interest rate.[1] The summary of estimates in this appendix also incorporates the assumption (based on current experience) that Federal and State grant programs would contribute 50% of capital costs for NRT for municipal facilities in Maryland, 0% for facilities in other States and the District of Columbia, and 10% in Virginia

### 2.1.3 Nitrogen Removal: Municipal Facilities

As described above, there are only Tier 1 costs for municipal facilities for the removal of nitrogen if these facilities are either currently operating NRT or are planning to by 2010 and have not already obtained funds for their efforts. Costs for facilities are estimated from data obtained directly from facilities or by applying an estimating methodology developed by the NRT Cost Task Force. The methods for estimating costs for Tiers 2 and 3 for nonreporting facilities (i.e., those that did not provide estimates) are described below.

**Tier 2.** The NRT Task Force used capital cost estimates received from reporting municipal facilities, including all facilities with design flow greater than 30.0 mgd. For the remaining facilities, since the nitrogen removal goals for municipal facilities in Tier 2 are the same as those for Tier 1 (8 mg/L TN), the Task Force used capital cost estimates for upgrading 67 facilities provided by U.S. EPA to extrapolate costs for upgrading nonreporting facilities to Tier 2 requirements. The estimates are based on actual construction costs, engineering design estimates, or preliminary engineering reports and facilities plans. The NRT Task Force fit a line to these data and estimated the following capital costs equation:

$$Capital\ Cost = 2{,}023{,}829 + 7 - 4{,}351.8039 \times Q - Q^2$$

where $Q$ = design flow between 0.5 and 30.0 mgd.

To estimate O&M costs, the NRT Task Force assumed that only facilities with ammonia concentrations greater than 2 mg/L would require additional nitrification to convert ammonia-N to nitrate-N. Most of the operations costs for Tier 2 are associated with the change in electrical requirements for aeration during biological treatment. The nitrification process requires oxygen, specifically, 4.57 lbs of oxygen per pound of ammonia nitrogen removed. Thus, the oxygen requirement can be calculated given a plant's effluent ammonia concentration. Once the oxygen requirement is known, the brake horsepower can be calculated using operating parameters for a typical aeration system.

The O&M costs also account for the possible denitrification energy cost savings due to lower oxygen requirements. The Task Force calculated electrical costs assuming 2.86 pounds of

[1] The 5.76% interest rate is based on the average market rate between 1998 and 2002 for business loans of between $100,000 and $10,000,000 (Federal Reserve, 2002a, 2001a, 2000a, 1999a, 1998a), and a marginal corporate tax rate of 20%. The average interest rate over the last five years is approximately 7.2%. Because loan repayments reduce corporate tax liability, the net interest rate on a loan reflects this tax advantage, which is 80% of the stated rate (i.e., 1–20%). Thus, the effective interest rate is 5.76% (7.2% x 0.8).

oxygen saved per pound of nitrate denitrified. In calculating nitrification and denitrification O&M costs, the Task Force used the projected 2010 flow rate. Change in solids production is negligible, and no additional labor is required. Maintenance costs are estimated as 2% of initial capital costs per year.

**Tier 3.** The NRT Task Force acknowledged certain improvements to a standard activated sludge plant would be necessary to achieve TN levels of 5 mg/L, and made the following assumptions:

- Plants are currently achieving TN of 8 mg/L
- Additional treatment comprises secondary anoxic zone with methanol addition following aeration and improvements to nitrification, clarification, flow splitting, and aeration
- Incremental costs include 30% program implementation associated with engineering, construction management, legal, bonding, and administrative fees.

The NRT Task Force fit lines to capital cost pollutant control estimates for plants with capacities of 0.1, 1.0, 10 and 30 mgd to develop separate cost curves:

| | |
|---|---|
| 0.1 mgd < Q < 1.0 mgd | $Capital\ Cost = 967.06 \times Q + 144.44$ |
| 1.0 mgd < Q < 30 mgd | $Capital\ Cost = 386.01 \times Q + 864.83$ |

The Task Force used a similar method to estimate O&M costs, using plant capacities of 0.1, 1.0, 10 and 30 mgd to develop linear cost curves. O&M costs include methanol purchase, handling, stabilization, and disposal or reuse costs from increased solids production, energy, and maintenance costs, and include the following assumptions:

- 3.1 pounds of methanol are needed for every pound of nitrate reduced
- Methanol costs are $1.00 per gallon for bulk storage, except for the 0.1 mgd plant where costs are $2.00 per gallon for a 55-gallon drum feed
- The process will yield 0.12 pounds of solids per pound of methanol applied
- Solids handling, stabilization and disposal or reuse costs are $300 per dry ton
- Energy costs for mixing and other uses for each plant size are $0.05/kWh
- Maintenance costs are 2% of initial capital costs.

### 2.1.4 Nitrogen Removal: Industrial Facilities

The industrial cost estimates are described in detail in NRT Cost Task Force (2002). As described above, there are no reductions in nitrogen from industrial facilities required under Tier 1. In general, Tier 2 reflects levels of reduction on the order of 50% from Tier 1 unless permit conditions are more stringent. Tier 3 reflects a reduction of about 80% beyond Tier 1 unless permit conditions are more stringent. For Tiers 2 and 3, the NRT Task Force developed costs based on 2000 effluent concentrations. The Task Force used site-specific cost estimates where they were provided; otherwise, it assumed that onsite controls or transportation of effluent to a POTW would be required. Estimated costs for Tiers 2 and 3 are zero whenever 2000 TN or TP concentrations are less than or approximately equal to the concentrations required by each tier. For the remaining facilities, the Task Force estimated costs using the same methodology as for municipal facilities, even where it is known that some industrial wastewater is not treatable biologically.

### 2.1.5 Phosphorus Removal: Municipal Facilities

As described above, there are only costs for municipal facilities for the removal of phosphorus if these facilities provided estimates for current or planned controls. The methods for estimating costs for Tiers 2 and 3 for facilities that did not provide estimates are described below.

**Tier 2.** The NRT Task Force developed costs based on 2000 TP effluent concentrations. Costs are zero for facilities with effluent already below the Tier 2 requirement of 1 mg/L TP. The Task Force assumed that facilities discharging between 1 mg/L and 2 mg/L TP are operating chemical precipitation, and would only require O&M costs associated with increased chemical addition and sludge handling. Removal of 1 mg/L of TP requires 14.4 mg/L of alum, which costs $269 per ton. Sludge handling costs are $300 per dry ton of sludge. The amount of sludge produced is calculated from the stoichiometric coefficients of the sludge reaction and the 2010 flow rate. Facilities discharging TP concentrations greater than 2 mg/L require treatment controls. The NRT Task Force assumed that facilities would install chemical precipitation using alum. Cost curves for chemical precipitation installation are:

| | |
|---|---|
| 0.1 mgd < Q < 1.0 mgd | $Capital\ Cost = 94{,}444 \times Q + 65{,}556$ |
| 1.0 mgd < Q < 30 mgd | $Capital\ Cost = 15{,}172 \times Q + 144{,}828$ |

The Task Force approximated costs for plants with capacities outside of this range using the maximum or minimum cost; it calculated O&M costs using the method for facilities discharging between 1 mg/L and 2 mg/L TP, and assumed maintenance costs of 2% of capital costs per year.

**Tier 3.** The NRT Task Force made the following assumptions in developing costs:

- Tier 2 requirements are already in place (i.e., facilities are already operating chemical precipitation), therefore, there are no additional capital costs

- Facilities are operating at 1.0 mg/L TP or less

- O&M costs are calculated as described in Tier 2.

### 2.1.5 Phosphorus Removal: Industrial Facilities

As described above, there are no reductions in phosphorus from industrial facilities required under Tier 1. For Tiers 2 and 3, the NRT Task Force estimated TP removal costs using the same methodology used to estimate TN removal costs.

### 2.1.6 Limitations and Uncertainties in the Analysis of Point Source Costs

There are a number of limitations and uncertainties inherent in the method for estimating point source costs. **Exhibit E-2** illustrates the sources of potential bias, and the potential impact on the estimates.

**Exhibit E-2: Sources of Uncertainty in the Point Source Cost Estimates**

| Source | Potential Impact on Costs | Comments |
|---|---|---|
| Costs for reducing TN and TP derived separately | + | Some technologies may control TN and TP simultaneously; thus costs could be lower to treat N and P at the same time |
| Costs may include growth-related costs not related to the tier scenarios | + | Planning-level estimates for 2010 may incorporate costs that would be incurred anyway to serve increased populations; no attempt is made to estimate baseline costs [upgrades necessary to treat 2010 flows sufficient to meet local water quality standards or anticipated total maximum daily loads (TMDLs) without implementation of the tier scenarios] |
| Costs include estimates provided by facilities for which no nutrient reductions are indicated | + | Current effluent concentrations for these facilities meet the levels specified in the tier scenarios |
| Costs include biological treatment to reduce TN and TP at many industrial facilities | ? | Biological treatment may not be a feasible option for certain industrial facilities, and more or less costly treatment controls may be needed instead |
| Estimates based on cost equations reflect the same treatment to reduce TN and TP levels at all facilities | ? | Costs are not based on facility-specific treatment processes or operational procedures and, therefore, may over- or underestimate costs |

+ = assumption results in overestimating costs
? = impact of assumption on cost estimates is unknown

## 2.2 Forestry, Agriculture, Urban, and OSWMS Sources

The tier scenarios also include varying implementation levels of nutrient reduction BMPs for agricultural operations, forest harvesting operations, urban and mixed open (land with herbaceous cover not classified as agricultural, urban, or forest) land, and onsite wastewater management systems (OSWMSs). Tier 1, which represents current implementation levels extended to 2010, incorporates the Phase I and Phase II Storm Water Rules and other ongoing State and local programs (e.g., nutrient management planning on crop and hay land in Maryland and Delaware). However, as described below, the degree to which it incorporates anticipated revisions to the concentrated animal feeding operation (CAFO) regulations and State programs submitted under the Coastal Zone Reauthorization Amendments (CZARA) of 1990 is unknown. **Exhibit E-3** summarizes the tier scenarios for these sources.

**Exhibit E-3: Nutrient Reduction Scenarios for Agriculture, Forestry, Urban, and OSWMS Sources**

| BMP | Tier 1 | Tier 2 | Tier 3 |
|---|---|---|---|
| **Agriculture: Cropland Conversions to Forest or Hayland** | | | |
| Forest buffers (Pasture) | Continue current level of implementation using average rate of 1997-2000. Includes fencing. | Increase level of implementation up to a total of 20% of the remaining stream reaches in pasture. Includes fencing. | Increase level of implementation up to a total of 30% of the remaining stream reaches in pasture. Includes fencing. |
| Forest buffers (Cropland) | Continue current level of implementation using average rate of 1997-2000. | Increase level of implementation up to a total of 20% of the remaining stream reaches in cropland. | Increase level of implementation up to a total of 30% of the remaining stream reaches in cropland. |
| Grass buffers (Cropland) | Continue current level of implementation using average rate of 1997-2000. | 25% of remaining stream reaches within cropland. | 50% of remaining stream reaches within cropland. |
| Forest buffers (Hayland) | Continue current level of implementation using average rate of 1997-2000. | 25% of remaining stream reaches within hayland over Tier 1. | 50% of remaining stream reaches within hayland over Tier 1. |
| Wetland restoration (Cropland) | Continue current level of implementation using average rate of 1997-2000. | Increase level of implementation up to a total of 33% of the remaining goal. | Increase level of implementation up to a total of 66% of the remaining goal. |
| Retirement of highly erodible land (HEL) | Continue current level of implementation using average rate of 1997-2000. | Retirement of HEL-Wetland Restoration-buffers (combined) comprise 10% of cropland within each county. | Retirement of HEL-Wetland Restoration-buffers (combined) comprise 15% of cropland within each county. |
| Carbon sequestration | Not applicable. | Not applicable. | Applied to 15% of remaining E3 cropland after land conversion programs applied. |

## Exhibit E-3: Nutrient Reduction Scenarios for Agriculture, Forestry, Urban, and OSWMS Sources

| BMP | Tier 1 | Tier 2 | Tier 3 |
|---|---|---|---|
| **Agriculture: BMPs on Cropland** | | | |
| Conservation tillage | Continue current level of implementation using average rate of 1997-2000. | Applied to 30% of remaining cropland beyond Tier 1. | Applied to 60% of remaining cropland beyond Tier 1. |
| Farm plans (soil conservation and water quality plans) | Continue current level of implementation using average rate of 1997-2000. | Applied to 30% of remaining agricultural land (crop, hay, pasture) beyond Tier 1. | Applied to 70% of remaining agricultural land (crop, hay, pasture) beyond Tier 1. |
| Cover crops | Continue current level of implementation using average rate of 1997-2000. | Applied to 40% of remaining cropland beyond Tier 1. | Applied to 75% of remaining cropland beyond Tier 1. |
| Nutrient management plan implementation | MD & DE: 100% of cropland and hayland. Other Basin States: Continue current level of implementation using average rate of 1997-2000. | MD & DE: 100% of cropland and hayland. Other Basin States: Applied to 30% of remaining cropland and hayland beyond Tier 1. | MD & DE: 100% cropland and hayland. Other Basin States: Applied to 30% of remaining cropland and hayland beyond Tier 2. |
| Yield reserve | Not applicable. | Not applicable. | Applied to 30% of the cropland and hayland under nutrient management. Replaces nutrient application component of nutrient management plan. |
| Excess manure removal | Assume alternative use for excess manure. | Assume alternative use for excess manure. | Assume alternative use for excess manure. |
| Animal waste management systems | Continue current level of implementation using average rate of 1997-2000. | Applied to 25% of remaining confined animal units beyond Tier 1 (combines storage system and barnyard runoff controls). | Applied to 60% of remaining confined animal units beyond Tier 1 (combines storage system and barnyard runoff controls). |
| Stream protection without fencing | Continue current level of implementation using average rate of 1997-2000. | Applied to 10% of remaining stream reaches within pasture land beyond Tier 1. | Applied to 25% of remaining stream reaches within pasture land beyond Tier 1. |
| Stream protection with fencing | Continue current level of implementation using average rate of 1997-2000. | Applied to 15% of remaining stream reaches within pasture land beyond Tier 1. | Applied to 75% of remaining stream reaches within pasture land beyond Tier 1. |
| Grazing land protection | Continue current level of implementation using average rate of 1997-2000. | Applied to 25% of remaining pasture land beyond Tier 1. | Applied to 50% of remaining pasture land beyond Tier 1. |

## Exhibit E-3: Nutrient Reduction Scenarios for Agriculture, Forestry, Urban, and OSWMS Sources

| BMP | Tier 1 | Tier 2 | Tier 3 |
|---|---|---|---|
| **Forestry** | | | |
| Forest harvesting BMPs (erosion control) | Forestry BMPs are properly installed on 80% of all harvested lands. | Forestry BMPs are properly installed on 90% of all harvested lands. | Forestry BMPs are properly installed on 100% of all harvested lands with no measurable increase in nutrient and sediment discharge. |
| **Urban and Mixed Open Land** | | | |
| Urban land conversion (signatories only) | Full 2000-2010 urban land conversion based on 2010 population. | 2000-2010 urban conversion – reduced 10% (acres "returned" as 65% forest, 20% mixed open, 15% agriculture). | 2000-2010 urban conversion – reduced 20% (acres "returned" as 65% forest, 20% mixed open, 15% agriculture). |
| Storm water management and low impact development – new development (2001-2010) | 66% of new development has storm water management (percent reduction: TN=35, TP=45, TSS=80). | 75% of new development has storm water management. 25% of new development employs environmental site design and low-impact development techniques. Efficiencies represent a 75%/25% weighted average reduction (TN=40, TP=55, TSS=85). | 50% of new development has storm water management. 50% of new development employs environmental site design and low-impact development techniques. Efficiencies represent a 50%/50% weighted average reduction (TN=45, TP=57, TSS=87). |
| Storm water management – recent development (1986-2000) | 60% of recent development has storm water management (percent reduction: TN=27, TP=40,TSS=65). | 60% of recent development in MD, PA, DC, VA has storm water management (percent reduction: TN=27, TP=40,TSS=65). | 60% of recent development in MD, PA, DC, VA has storm water management (percent reduction: TN=27, TP=40,TSS=65). |
| Storm water retrofits – recent (1986–2000) and old (pre 1986) development | 0.8% of recent and old (pre 1986) development is retrofitted (percent reduction: TN=20, TP=30,TSS=65). | 5% of recent and old (pre 1986) development is retrofitted (percent reduction: TN=20, TP=30,TSS=65). | 20% of recent and old (pre 1986) development is retrofitted (percent reduction: TN=20, TP=30,TSS=65). |
| Urban nutrient management | Continue to implement BMP at average annual rate through 2010, using average of 1997-2000 (percent reduction: TN=17%, TP=22%). | 40% of urban pervious and mixed open lands are under nutrient management (percent reduction: TN=17%, TP=22%). | 75% of urban pervious and mixed open lands are under nutrient management (percent reduction TN=17%, TP=22%). |

**Exhibit E-3: Nutrient Reduction Scenarios for Agriculture, Forestry, Urban, and OSWMS Sources**

| BMP | Tier 1 | Tier 2 | Tier 3 |
|---|---|---|---|
| **Urban and Mixed Open Land (Continued)** | | | |
| Grass buffers (urban land) | All urban stream reaches are assumed to have either grass or tree buffers. Where urban disturbance has altered a stream reach beyond repair/restoration, it is not included as a potential buffer area. | Reduce grass buffers by 10% below Tier 1 level (conversion to forest buffers). | Reduce grass buffers by 30% below Tier 1 level (conversion to forest buffers). |
| Forest buffers (urban land) | Not applicable. | Increase forest buffer acreage by the same amount of "reduced" grass buffer acreage. | Increase forest buffer acreage by the same amount of "reduced" grass buffer acreage. |
| Forest buffers (mixed open land) | Continue current level of implementation using average rate of 1997-2000. | Increase forest buffer acreage by the same amount as forest buffers on urban pervious. | Increase forest buffer acreage by the same amount as forest buffers on urban pervious. |
| **Onsite Treatment Systems** | | | |
| Denitrification with pumping (new systems, i.e., post 2000) | Maintain current concentration/load per system (36 mg/l TN). | 10% of new treatment systems will meet a concentration for nitrogen of 10 mg/L TN per system at the edge-of-the adsorption field. Remaining systems meet existing concentration/load levels. | 100% of new treatment systems will achieve 10 mg/L TN at the edge of the adsorption field. |
| Denitrification with pumping (existing systems, i.e., pre-2001) | Maintain current concentration/load per system (36 mg/l TN). | Maintain current concentration/load per system (36 mg/l TN). | 1% of existing (per year) treatment systems will achieve 10 mg/L TN at the edge of the adsorption field (1% represents failed systems and opportunities for upgrades). Remaining systems maintain existing concentrations/loads. |

HEL = Highly erodible land
TN = total nitrogen
TP = total phosphorus
TSS = total suspended solids.

U.S. EPA anticipates that CAFOs will incur costs to implement or improve animal waste management systems, develop and implement nutrient management plans, and transfer excess manure offsite under revisions to the effluent guidelines for this sector. However, because EPA is still finalizing the CAFO rule, the extent of overlap with the tier scenarios is unknown. For instance, although Tier 1 requirements for animal waste systems indicate continuing the level of implementation based on the average rate of 1997–2000 (Exhibit E-3), this level is most likely lower than would be required under the final CAFO regulations.

Section 6217 of the CZARA requires 29 States and Territories, including the Basin States of Delaware, Maryland, New York, Pennsylvania, and Virginia, to develop programs to implement practices to control nonpoint source pollution in areas where land and water uses have a significant impact on coastal waters. Although State program were supposed to be approved by 1995 and fully implemented by 1999, this schedule has not been met. Administrative changes in 1998 required that participating States submit 15-year program strategies outlining the NPS management measures they plan to implement through a sequence of 5-year an implementation plans that coordinate BMP implementation with other programs such as the CBP. Management measures can differ by State depending on the relative impact of different types of NPS on water quality. Thus, BMP implementation that would occur under Section 6217 of CZARA may overlap the tiers to an unknown degree for the following controls:

- Agricultural BMPs, including forest riparian buffers, nutrient management plans, animal waste management, excess manure removal, stream protection, grazing land protection, conservation tillage, wetland restoration, and retirement of erodible land
- Silvicultural BMPs, including forest harvesting practices to reduce erosion
- Urban BMPs, including environmental site design and urban riparian forest and grass buffers
- Onsite disposal system BMPs, including denitrification.

**Exhibit E-4** provides the number of incremental acres of each BMP or number of systems for onsite wastewater management systems (i.e., beyond acres or systems in the 2000 Progress scenario) that correspond to the scenario descriptions in Exhibit E-3. Negative numbers indicate that BMP implementation is currently greater in the Progress 2000 scenario than required by the tier scenario. For the BMPs that are applied to land, this reflects a change in land use. The change may be caused by an actual conversion of land from agricultural to other uses, for instance, because of urban growth projected to occur between 2000 and 2010. It also may be caused by agricultural BMPs that cause land to shift from one agricultural land use category to another. For example, higher implementation rates of forest or grass buffers, wetlands restoration, carbon sequestration, and retirement of highly erodible land BMPs on high till land leaves less land available for the conservation tillage BMP. In some cases, the conservation tillage acreage is actually negative because the total number of acres in the tier scenario is lower than the number of acres in Progress 2000. Negative numbers for excess manure removal in Maryland are related to a projected decline in the number of animal units in Maryland from 2000

to 2010, as well as shifting animal types between 2000 and 2010 and variation in the nutrient content of the manure of different animal species, and shifting land uses to which the manure can be applied.

When these reductions in acres are multiplied by the estimated annual practice costs, the result will be a cost savings. For instance, cover crop costs are incurred every year, and if the land is converted out of agricultural production, the cover crop costs will no longer be incurred. However, Exhibit E-4 does not report net reductions in implementation for practices for which the major portion of the annual cost is a sunk cost (e.g., forest buffers), because no cost savings will occur from the land conversion or changes in BMP application.

## Exhibit E-4: Tier 1 BMP Scenario: Delaware

| BMP | Number of Acres[1] | | | |
|---|---|---|---|---|
| **Urban** | **Pervious** | **Impervious** | **Ultra** | **Mixed Open** |
| Forest Buffers | 2 | - | - | 0 |
| Grass Buffers | 565 | - | - | - |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | - | - |
| Storm Water Retrofits | 139 | 42 | 0 | - |
| Storm Water Management on New Dev. | 1,137 | 425 | - | - |
| Nutrient Management | 0 | - | - | 60,791 |
| Urban Land Conversion | 0 | 0 | - | - |
| Forest Conservation | 0 | 0 | - | - |

| **Agriculture[2]** | **High Till** | **Low Till** | **Hay** | **Pasture** | **Manure** |
|---|---|---|---|---|---|
| Forest Buffers | 713 | 1,747 | 72 | 21 | - |
| Grass Buffers | 312 | 762 | - | - | - |
| Wetland Restoration | 56 | 133 | 4 | 0 | - |
| Retirement of Highly Erodible Land | 0 | 0 | 0 | - | - |
| Tree Planting | 0 | 0 | - | 0 | - |
| Farm Plans | 0 | 0 | 0 | 0 | - |
| Cover Crops | -8 | 8 | - | - | - |
| Stream Protection w/ Fencing | - | - | - | 0 | - |
| Stream Protection w/o Fencing | - | - | - | 0 | - |
| Nutrient Management Plan Implementation | 49,761 | 112,223 | 4,872 | - | - |
| Grazing Land Protection | - | - | - | 0 | - |
| Animal Waste Management Systems | - | - | - | - | 4 |
| Yield Reserve | 0 | 0 | 0 | - | - |
| Carbon Sequestration | 0 | 0 | - | - | - |
| Excess Manure Removal | - | - | - | - | 71,287 |
| Conservation Tillage | 721 | - | - | - | - |

| **Forest** | **Forest Land** |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 175 |

| **Onsite Wastewater Management Systems** | **Existing Systems** | **New Systems** |
|---|---|---|
| Denitrification w/ Pumping[3] | 0 | 0 |

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.

2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.

3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

## Exhibit E-4: Tier 1 BMP Scenario: District of Columbia

| BMP | Number of Acres[1] | | | |
|---|---|---|---|---|
| **Urban** | **Pervious** | **Impervious** | **Ultra** | **Mixed Open** |
| Forest Buffers | 1 | - | - | 0 |
| Grass Buffers | 144 | - | - | - |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | - | - |
| Storm Water Retrofits | 138 | 0 | 148 | - |
| Storm Water Management on New Dev. | 0 | 0 | - | - |
| Nutrient Management | 0 | - | - | 0 |
| Urban Land Conversion | 0 | 0 | - | - |
| Forest Conservation | 0 | 0 | - | - |

| **Agriculture[2]** | **High Till** | **Low Till** | **Hay** | **Pasture** | **Manure** |
|---|---|---|---|---|---|
| Forest Buffers | 0 | 0 | 0 | 0 | - |
| Grass Buffers | 0 | 0 | - | - | - |
| Wetland Restoration | 0 | 0 | 0 | 0 | - |
| Retirement of Highly Erodible Land | 0 | 0 | 0 | - | - |
| Tree Planting | 0 | 0 | - | 0 | - |
| Farm Plans | 0 | 0 | 0 | 0 | - |
| Cover Crops | 0 | 0 | - | - | - |
| Stream Protection w/ Fencing | - | - | - | 0 | - |
| Stream Protection w/o Fencing | - | - | - | 0 | - |
| Nutrient Management Plan Implementation | 0 | 0 | 0 | - | - |
| Grazing Land Protection | - | - | - | 0 | - |
| Animal Waste Management Systems | - | - | - | - | 0 |
| Yield Reserve | 0 | 0 | 0 | - | - |
| Carbon Sequestration | 0 | 0 | - | - | - |
| Excess Manure Removal | - | - | - | - | 0 |
| Conservation Tillage | 0 | - | - | - | - |

| **Forest** | **Forest Land** |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 0 |

| **Onsite Wastewater Management Systems** | **Existing Systems** | **New Systems** |
|---|---|---|
| Denitrification w/ Pumping[3] | 0 | 0 |

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

## Exhibit E-4: Tier 1 BMP Scenario: Maryland

| BMP | Number of Acres[1] | | | |
|---|---|---|---|---|
| **Urban** | **Pervious** | **Impervious** | **Ultra** | **Mixed Open** |
| Forest Buffers | 77 | - | - | 5,223 |
| Grass Buffers | 20,042 | - | - | - |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | - | - |
| Storm Water Retrofits | 5,621 | 2,680 | 74 | - |
| Storm Water Management on New Dev. | 52,875 | 23,912 | - | - |
| Nutrient Management | 0 | - | - | 0 |
| Urban Land Conversion | 0 | 0 | - | - |
| Forest Conservation | 0 | 0 | - | - |

| **Agriculture[2]** | **High Till** | **Low Till** | **Hay** | **Pasture** | **Manure** |
|---|---|---|---|---|---|
| Forest Buffers | 4,999 | 7,682 | 2,048 | 3,106 | - |
| Grass Buffers | 2,387 | 5,316 | - | - | - |
| Wetland Restoration | 0 | 0 | 0 | 0 | - |
| Retirement of Highly Erodible Land | 460 | 655 | 261 | - | - |
| Tree Planting | 0 | 0 | - | 0 | - |
| Farm Plans | 28,908 | 15,730 | 20,901 | -15,416 | - |
| Cover Crops | -12,699 | -19,262 | - | - | - |
| Stream Protection w/ Fencing | - | - | - | 14,468 | - |
| Stream Protection w/o Fencing | - | - | - | 2,965 | - |
| Nutrient Management Plan Implementation | 52,963 | 51,298 | 20,392 | - | - |
| Grazing Land Protection | - | - | - | 0 | - |
| Animal Waste Management Systems | - | - | - | - | 94 |
| Yield Reserve | 0 | 0 | 0 | - | - |
| Carbon Sequestration | 0 | 0 | - | - | - |
| Excess Manure Removal | - | - | - | - | -4,229 |
| Conservation Tillage | -53,587 | - | - | - | - |

| **Forest** | **Forest Land** |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 18,959 |

| **Onsite Wastewater Management Systems** | **Existing Systems** | **New Systems** |
|---|---|---|
| Denitrification w/ Pumping[3] | 0 | 0 |

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

## Exhibit E-4: Tier 1 BMP Scenario: New York

| BMP | Number of Acres[1] | | | |
|---|---|---|---|---|
| **Urban** | **Pervious** | **Impervious** | **Ultra** | **Mixed Open** |
| Forest Buffers | 18 | - | - | 0 |
| Grass Buffers | 4,755 | - | - | - |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | - | - |
| Storm Water Retrofits | 1,103 | 540 | 0 | - |
| Storm Water Management on New Dev. | 1,229 | 1,351 | - | - |
| Nutrient Management | 0 | - | - | 0 |
| Urban Land Conversion | 0 | 0 | - | - |
| Forest Conservation | 0 | 0 | - | - |

| **Agriculture[2]** | **High Till** | **Low Till** | **Hay** | **Pasture** | **Manure** |
|---|---|---|---|---|---|
| Forest Buffers | 0 | 0 | 0 | 0 | - |
| Grass Buffers | 0 | 0 | - | - | - |
| Wetland Restoration | 0 | 0 | 0 | 0 | - |
| Retirement of Highly Erodible Land | 1,840 | 630 | 3,546 | - | - |
| Tree Planting | 0 | 0 | - | 0 | - |
| Farm Plans | 0 | 0 | 0 | 0 | - |
| Cover Crops | 0 | 0 | - | - | - |
| Stream Protection w/ Fencing | - | - | - | 0 | - |
| Stream Protection w/o Fencing | - | - | - | 0 | - |
| Nutrient Management Plan Implementation | 2,936 | 3,238 | 11,867 | - | - |
| Grazing Land Protection | - | - | - | 7,750 | - |
| Animal Waste Management Systems | - | - | - | - | 124 |
| Yield Reserve | 0 | 0 | 0 | - | - |
| Carbon Sequestration | 0 | 0 | - | - | - |
| Excess Manure Removal | - | - | - | - | 0 |
| Conservation Tillage | 10,975 | - | - | - | - |

| **Forest** | **Forest Land** |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 43,278 |

| **Onsite Wastewater Management Systems** | **Existing Systems** | **New Systems** |
|---|---|---|
| Denitrification w/ Pumping[3] | 0 | 0 |

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.

2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.

3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

## Exhibit E-4: Tier 1 BMP Scenario: Pennsylvania

| BMP | Number of Acres[1] | | | |
|---|---|---|---|---|
| **Urban** | **Pervious** | **Impervious** | **Ultra** | **Mixed Open** |
| Forest Buffers | 89 | - | - | 16,461 |
| Grass Buffers | 23,134 | - | - | - |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | - | - |
| Storm Water Retrofits | 4,142 | 2,269 | 0 | - |
| Storm Water Management on New Dev. | 4,799 | 5,978 | - | - |
| Nutrient Management | 0 | - | - | 0 |
| Urban Land Conversion | 0 | 0 | - | - |
| Forest Conservation | 0 | 0 | - | - |

| **Agriculture[2]** | **High Till** | **Low Till** | **Hay** | **Pasture** | **Manure** |
|---|---|---|---|---|---|
| Forest Buffers | 0 | 0 | 0 | 1,015 | - |
| Grass Buffers | 165 | 96 | - | - | - |
| Wetland Restoration | 149 | 80 | 174 | 0 | - |
| Retirement of Highly Erodible Land | 2,826 | 2,408 | 0 | - | - |
| Tree Planting | 0 | 0 | - | 0 | - |
| Farm Plans | 436,031 | 9,190 | 14,030 | 18,254 | - |
| Cover Crops | 0 | 0 | - | - | - |
| Stream Protection w/ Fencing | - | - | - | 6,862 | - |
| Stream Protection w/o Fencing | - | - | - | 746 | - |
| Nutrient Management Plan Implementation | 193,001 | 11,878 | 0 | - | - |
| Grazing Land Protection | - | - | - | 3,193 | - |
| Animal Waste Management Systems | - | - | - | - | 1,334 |
| Yield Reserve | 0 | 0 | 0 | - | - |
| Carbon Sequestration | 0 | 0 | - | - | - |
| Excess Manure Removal | - | - | - | - | 3,092 |
| Conservation Tillage | 58,426 | - | - | - | - |

| **Forest** | **Forest Land** |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 165,242 |

| **Onsite Wastewater Management Systems** | **Existing Systems** | **New Systems** |
|---|---|---|
| Denitrification w/ Pumping[3] | 0 | 0 |

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.

2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.

3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

## Exhibit E-4: Tier 1 BMP Scenario: Virginia

| BMP | Number of Acres[1] | | | |
|---|---|---|---|---|
| **Urban** | **Pervious** | **Impervious** | **Ultra** | **Mixed Open** |
| Forest Buffers | 170 | - | - | 0 |
| Grass Buffers | 44,440 | - | - | - |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | - | - |
| Storm Water Retrofits | 8,595 | 3,807 | 104 | - |
| Storm Water Management on New Dev. | 31,661 | 27,603 | - | - |
| Nutrient Management | 22,022 | - | - | 0 |
| Urban Land Conversion | 0 | 0 | - | - |
| Forest Conservation | 0 | 0 | - | - |

| **Agriculture[2]** | **High Till** | **Low Till** | **Hay** | **Pasture** | **Manure** |
|---|---|---|---|---|---|
| Forest Buffers | 1,074 | 2,092 | 969 | 0 | - |
| Grass Buffers | 566 | 820 | - | - | - |
| Wetland Restoration | 103 | 347 | 552 | 0 | - |
| Retirement of Highly Erodible Land | 3,073 | 7,436 | 20,871 | - | - |
| Tree Planting | 0 | 0 | - | 0 | - |
| Farm Plans | 37,760 | 110,244 | 206,110 | 298,315 | - |
| Cover Crops | -16,833 | -18,224 | - | - | - |
| Stream Protection w/ Fencing | - | - | - | 10,170 | - |
| Stream Protection w/o Fencing | - | - | - | 0 | - |
| Nutrient Management Plan Implementation | 29,986 | 72,414 | 107,210 | - | - |
| Grazing Land Protection | - | - | - | 106,729 | - |
| Animal Waste Management Systems | - | - | - | - | 211 |
| Yield Reserve | 0 | 0 | 0 | - | - |
| Carbon Sequestration | 0 | 0 | - | - | - |
| Excess Manure Removal | - | - | - | - | 587,611 |
| Conservation Tillage | -38,965 | - | - | - | - |

| **Forest** | **Forest Land** |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 35,943 |

| **Onsite Wastewater Management Systems** | **Existing Systems** | **New Systems** |
|---|---|---|
| Denitrification w/ Pumping[3] | 0 | 0 |

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.

2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.

3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

# Exhibit E-4: Tier 1 BMP Scenario: West Virginia

**BMP** **Number of Acres[1]**

| Urban | Pervious | Impervious | Ultra | Mixed Open |
|---|---|---|---|---|
| Forest Buffers | 7 | - | - | 0 |
| Grass Buffers | 1,941 | - | - | - |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | - | - |
| Storm Water Retrofits | 379 | 177 | 0 | - |
| Storm Water Management on New Dev. | 1,342 | 845 | - | - |
| Nutrient Management | 0 | - | - | 0 |
| Urban Land Conversion | 0 | 0 | - | - |
| Forest Conservation | 0 | 0 | - | - |

| Agriculture[2] | High Till | Low Till | Hay | Pasture | Manure |
|---|---|---|---|---|---|
| Forest Buffers | 21 | 38 | 189 | 0 | - |
| Grass Buffers | 138 | 232 | - | - | - |
| Wetland Restoration | 0 | 0 | 0 | 0 | - |
| Retirement of Highly Erodible Land | 15 | 44 | 312 | - | - |
| Tree Planting | 0 | 0 | - | 0 | - |
| Farm Plans | 7,789 | 7,381 | 70,643 | 143,516 | - |
| Cover Crops | -559 | 210 | - | - | - |
| Stream Protection w/ Fencing | - | - | - | 600 | - |
| Stream Protection w/o Fencing | - | - | - | 4 | - |
| Nutrient Management Plan Implementation | 718 | 2,084 | 13,478 | - | - |
| Grazing Land Protection | - | - | - | 57,194 | - |
| Animal Waste Management Systems | - | - | - | - | 37 |
| Yield Reserve | 0 | 0 | 0 | - | - |
| Carbon Sequestration | 0 | 0 | - | - | - |
| Excess Manure Removal | - | - | - | - | 0 |
| Conservation Tillage | -9,491 | - | - | - | - |

| Forest | Forest Land |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 15,816 |

| Onsite Wastewater Management Systems | Existing Systems | New Systems |
|---|---|---|
| Denitrification w/ Pumping[3] | 0 | 0 |

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.

2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.

3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

## Exhibit E-4: Tier 2 BMP Scenario: Delaware

| BMP | Number of Acres[1] | | | |
|---|---|---|---|---|
| **Urban** | **Pervious** | **Impervious** | **Ultra** | **Mixed Open** |
| Forest Buffers | 59 | - | - | 56 |
| Grass Buffers | 508 | - | - | - |
| Environmental Site Design / Low-Impact Dev. | 431 | 161 | - | - |
| Storm Water Retrofits | 868 | 260 | 0 | - |
| Storm Water Management on New Dev. | 1,292 | 483 | - | - |
| Nutrient Management | 7,634 | - | - | 74,473 |
| Urban Land Conversion | 0 | 0 | - | - |
| Forest Conservation | 0 | 0 | - | - |

| **Agriculture[2]** | **High Till** | **Low Till** | **Hay** | **Pasture** | **Manure** |
|---|---|---|---|---|---|
| Forest Buffers | 696 | 3,166 | 123 | 283 | - |
| Grass Buffers | 391 | 1,710 | - | - | - |
| Wetland Restoration | 30 | 159 | 4 | 0 | - |
| Retirement of Highly Erodible Land | 2,683 | 9,716 | 369 | - | - |
| Tree Planting | 0 | 0 | - | 0 | - |
| Farm Plans | 10,078 | 36,604 | 1,389 | 1,351 | - |
| Cover Crops | 13,413 | 48,800 | - | - | - |
| Stream Protection w/ Fencing | - | - | - | 168 | - |
| Stream Protection w/o Fencing | - | - | - | 95 | - |
| Nutrient Management Plan Implementation | 30,784 | 116,373 | 4,452 | - | - |
| Grazing Land Protection | - | - | - | 1,126 | - |
| Animal Waste Management Systems | - | - | - | - | 5 |
| Yield Reserve | 0 | 0 | 0 | - | - |
| Carbon Sequestration | 0 | 0 | - | - | - |
| Excess Manure Removal | - | - | - | - | 71,374 |
| Conservation Tillage | 4,871 | - | - | - | - |

| **Forest** | **Forest Land** |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 524 |

| **Onsite Wastewater Management Systems** | **Existing Systems** | **New Systems** |
|---|---|---|
| Denitrification w/ Pumping[3] | 0 | 318 |

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.

2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.

3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

## Exhibit E-4: Tier 2 BMP Scenario: District of Columbia

| BMP | Number of Acres[1] | | | |
|---|---|---|---|---|
| **Urban** | **Pervious** | **Impervious** | **Ultra** | **Mixed Open** |
| Forest Buffers | 15 | - | - | 14 |
| Grass Buffers | 130 | - | - | - |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | - | - |
| Storm Water Retrofits | 863 | 0 | 928 | - |
| Storm Water Management on New Dev. | 0 | 0 | - | - |
| Nutrient Management | 6,908 | - | - | 298 |
| Urban Land Conversion | 0 | 0 | - | - |
| Forest Conservation | 0 | 0 | - | - |

| **Agriculture[2]** | **High Till** | **Low Till** | **Hay** | **Pasture** | **Manure** |
|---|---|---|---|---|---|
| Forest Buffers | 0 | 0 | 0 | 0 | - |
| Grass Buffers | 0 | 0 | - | - | - |
| Wetland Restoration | 0 | 0 | 0 | 0 | - |
| Retirement of Highly Erodible Land | 0 | 0 | 0 | - | - |
| Tree Planting | 0 | 0 | - | 0 | - |
| Farm Plans | 0 | 0 | 0 | 0 | - |
| Cover Crops | 0 | 0 | - | - | - |
| Stream Protection w/ Fencing | - | - | - | 0 | - |
| Stream Protection w/o Fencing | - | - | - | 0 | - |
| Nutrient Management Plan Implementation | 0 | 0 | 0 | - | - |
| Grazing Land Protection | - | - | - | 0 | - |
| Animal Waste Management Systems | - | - | - | - | 0 |
| Yield Reserve | 0 | 0 | 0 | - | - |
| Carbon Sequestration | 0 | 0 | - | - | - |
| Excess Manure Removal | - | - | - | - | 0 |
| Conservation Tillage | 0 | - | - | - | - |

| **Forest** | **Forest Land** |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 0 |

| **Onsite Wastewater Management Systems** | **Existing Systems** | **New Systems** |
|---|---|---|
| Denitrification w/ Pumping[3] | 0 | 19 |

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.

2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.

3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

# Exhibit E-4: Tier 2 BMP Scenario: Maryland

**BMP** **Number of Acres[1]**

| Urban | Pervious | Impervious | Ultra | Mixed Open |
|---|---|---|---|---|
| Forest Buffers | 2,057 | - | - | 7,571 |
| Grass Buffers | 17,824 | - | - | - |
| Environmental Site Design / Low-Impact Dev. | 17,760 | 8,097 | - | - |
| Storm Water Retrofits | 35,119 | 16,750 | 462 | - |
| Storm Water Management on New Dev. | 53,280 | 24,290 | - | - |
| Nutrient Management | 309,371 | - | - | 313,801 |
| Urban Land Conversion | 9,590 | 3,844 | - | - |
| Forest Conservation | 0 | 0 | - | - |

| Agriculture[2] | High Till | Low Till | Hay | Pasture | Manure |
|---|---|---|---|---|---|
| Forest Buffers | 6,731 | 20,597 | 3,936 | 9,321 | - |
| Grass Buffers | 4,617 | 15,111 | - | - | - |
| Wetland Restoration | 1,202 | 3,108 | 639 | 0 | - |
| Retirement of Highly Erodible Land | 21,185 | 55,136 | 11,588 | - | - |
| Tree Planting | 0 | 0 | - | 0 | - |
| Farm Plans | -128,557 | 77,256 | 9,403 | -18,062 | - |
| Cover Crops | 72,590 | 249,608 | - | - | - |
| Stream Protection w/ Fencing | - | - | - | 16,722 | - |
| Stream Protection w/o Fencing | - | - | - | 3,031 | - |
| Nutrient Management Plan Implementation | -109,167 | 108,552 | 6,860 | - | - |
| Grazing Land Protection | - | - | - | 44,956 | - |
| Animal Waste Management Systems | - | - | - | - | 99 |
| Yield Reserve | 0 | 0 | 0 | - | - |
| Carbon Sequestration | 0 | 0 | - | - | - |
| Excess Manure Removal | - | - | - | - | -4,712 |
| Conservation Tillage | 3,667 | - | - | - | - |

| Forest | Forest Land |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 21,328 |

| Onsite Wastewater Management Systems | Existing Systems | New Systems |
|---|---|---|
| Denitrification w/ Pumping[3] | 0 | 3,226 |

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.

2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.

3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

# Exhibit E-4: Tier 2 BMP Scenario: New York

**BMP** — **Number of Acres**[1]

| Urban | Pervious | Impervious | Ultra | Mixed Open |
|---|---|---|---|---|
| Forest Buffers | 494 | - | - | 476 |
| Grass Buffers | 4,280 | - | - | - |
| Environmental Site Design / Low-Impact Dev. | 465 | 512 | - | - |
| Storm Water Retrofits | 6,891 | 3,375 | 0 | - |
| Storm Water Management on New Dev. | 1,396 | 1,536 | - | - |
| Nutrient Management | 55,875 | - | - | 231,893 |
| Urban Land Conversion | 0 | 0 | - | - |
| Forest Conservation | 0 | 0 | - | - |

| Agriculture[2] | High Till | Low Till | Hay | Pasture | Manure |
|---|---|---|---|---|---|
| Forest Buffers | 1,857 | 1,254 | 4,060 | 2,416 | - |
| Grass Buffers | 1,857 | 1,254 | - | - | - |
| Wetland Restoration | 0 | 0 | 0 | 0 | - |
| Retirement of Highly Erodible Land | 6,806 | 7,700 | 15,616 | - | - |
| Tree Planting | 0 | 0 | - | 0 | - |
| Farm Plans | 37,425 | 24,979 | 66,070 | 53,963 | - |
| Cover Crops | 49,901 | 33,306 | - | - | - |
| Stream Protection w/ Fencing | - | - | - | 7,521 | - |
| Stream Protection w/o Fencing | - | - | - | 4,262 | - |
| Nutrient Management Plan Implementation | 33,791 | 29,636 | 71,136 | - | - |
| Grazing Land Protection | - | - | - | 46,753 | - |
| Animal Waste Management Systems | - | - | - | - | 267 |
| Yield Reserve | 0 | 0 | 0 | - | - |
| Carbon Sequestration | 0 | 0 | - | - | - |
| Excess Manure Removal | - | - | - | - | 0 |
| Conservation Tillage | 61,590 | - | - | - | - |

| Forest | Forest Land |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 48,688 |

| Onsite Wastewater Management Systems | Existing Systems | New Systems |
|---|---|---|
| Denitrification w/ Pumping[3] | 0 | 596 |

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.

2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.

3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

## Exhibit E-4: Tier 2 BMP Scenario: Pennsylvania

| BMP | Number of Acres[1] | | | |
|---|---|---|---|---|
| **Urban** | **Pervious** | **Impervious** | **Ultra** | **Mixed Open** |
| Forest Buffers | 2,395 | - | - | 19,377 |
| Grass Buffers | 20,753 | - | - | - |
| Environmental Site Design / Low-Impact Dev. | 1,471 | 2,038 | - | - |
| Storm Water Retrofits | 25,871 | 14,182 | 0 | - |
| Storm Water Management on New Dev. | 4,413 | 6,113 | - | - |
| Nutrient Management | 209,320 | - | - | 608,303 |
| Urban Land Conversion | 1,811 | 906 | - | - |
| Forest Conservation | 0 | 0 | - | - |

| **Agriculture[2]** | **High Till** | **Low Till** | **Hay** | **Pasture** | **Manure** |
|---|---|---|---|---|---|
| Forest Buffers | 11,677 | 16,545 | 21,614 | 8,298 | - |
| Grass Buffers | 11,738 | 16,660 | - | - | - |
| Wetland Restoration | 320 | 618 | 543 | 0 | - |
| Retirement of Highly Erodible Land | 34,190 | 66,994 | 79,070 | - | - |
| Tree Planting | 0 | 0 | - | 0 | - |
| Farm Plans | -209,479 | 307,677 | 527,958 | 200,582 | - |
| Cover Crops | 255,759 | 359,457 | - | - | - |
| Stream Protection w/ Fencing | - | - | - | 29,784 | - |
| Stream Protection w/o Fencing | - | - | - | 13,638 | - |
| Nutrient Management Plan Implementation | -220,562 | 535,373 | 490,787 | - | - |
| Grazing Land Protection | - | - | - | 119,935 | - |
| Animal Waste Management Systems | - | - | - | - | 1,625 |
| Yield Reserve | 0 | 0 | 0 | - | - |
| Carbon Sequestration | 0 | 0 | - | - | - |
| Excess Manure Removal | - | - | - | - | 130,570 |
| Conservation Tillage | 269,892 | - | - | - | - |

| **Forest** | **Forest Land** |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 185,897 |

| **Onsite Wastewater Management Systems** | **Existing Systems** | **New Systems** |
|---|---|---|
| Denitrification w/ Pumping[3] | 0 | 1,346 |

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.

2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.

3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

# Exhibit E-4: Tier 2 BMP Scenario: Virginia

**BMP** **Number of Acres[1]**

| Urban | Pervious | Impervious | Ultra | Mixed Open |
|---|---|---|---|---|
| Forest Buffers | 4,587 | - | - | 4,417 |
| Grass Buffers | 39,755 | - | - | - |
| Environmental Site Design / Low-Impact Dev. | 10,395 | 9,768 | - | - |
| Storm Water Retrofits | 53,695 | 23,787 | 655 | - |
| Storm Water Management on New Dev. | 31,186 | 29,303 | - | - |
| Nutrient Management | 439,581 | - | - | 689,638 |
| Urban Land Conversion | 7,160 | 2,785 | - | - |
| Forest Conservation | 0 | 0 | - | - |

| Agriculture[2] | High Till | Low Till | Hay | Pasture | Manure |
|---|---|---|---|---|---|
| Forest Buffers | 4,585 | 11,327 | 13,122 | 19,777 | - |
| Grass Buffers | 4,125 | 9,438 | - | - | - |
| Wetland Restoration | 276 | 894 | 1,255 | 0 | - |
| Retirement of Highly Erodible Land | 13,147 | 34,438 | 50,013 | - | - |
| Tree Planting | 0 | 0 | - | 0 | - |
| Farm Plans | -39,267 | 189,619 | 310,139 | 524,263 | - |
| Cover Crops | 58,905 | 170,646 | - | - | - |
| Stream Protection w/ Fencing | - | - | - | 60,332 | - |
| Stream Protection w/o Fencing | - | - | - | 28,535 | - |
| Nutrient Management Plan Implementation | -8,866 | 154,443 | 268,710 | - | - |
| Grazing Land Protection | - | - | - | 388,064 | - |
| Animal Waste Management Systems | - | - | - | - | 267 |
| Yield Reserve | 0 | 0 | 0 | - | - |
| Carbon Sequestration | 0 | 0 | - | - | - |
| Excess Manure Removal | - | - | - | - | 677,907 |
| Conservation Tillage | 13,427 | - | - | - | - |

| Forest | Forest Land |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 48,540 |

| Onsite Wastewater Management Systems | Existing Systems | New Systems |
|---|---|---|
| Denitrification w/ Pumping[3] | 0 | 2,252 |

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.

2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.

3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

## Exhibit E-4: Tier 2 BMP Scenario: West Virginia

**BMP** **Number of Acres[1]**

| Urban | Pervious | Impervious | Ultra | Mixed Open |
|---|---|---|---|---|
| Forest Buffers | 202 | - | - | 194 |
| Grass Buffers | 1,747 | - | - | - |
| Environmental Site Design / Low-Impact Dev. | 508 | 320 | - | - |
| Storm Water Retrofits | 2,371 | 1,107 | 0 | - |
| Storm Water Management on New Dev. | 1,525 | 960 | - | - |
| Nutrient Management | 19,780 | - | - | 79,091 |
| Urban Land Conversion | 0 | 0 | - | - |
| Forest Conservation | 0 | 0 | - | - |

| Agriculture[2] | High Till | Low Till | Hay | Pasture | Manure |
|---|---|---|---|---|---|
| Forest Buffers | 202 | 446 | 2,892 | 6,637 | - |
| Grass Buffers | 234 | 596 | - | - | - |
| Wetland Restoration | 0 | 0 | 0 | 0 | - |
| Retirement of Highly Erodible Land | 942 | 2,542 | 10,506 | - | - |
| Tree Planting | 0 | 0 | - | 0 | - |
| Farm Plans | 1,304 | 9,688 | 58,958 | 140,496 | - |
| Cover Crops | 2,107 | 10,009 | - | - | - |
| Stream Protection w/ Fencing | - | - | - | 20,109 | - |
| Stream Protection w/o Fencing | - | - | - | 11,056 | - |
| Nutrient Management Plan Implementation | 2,238 | 9,494 | 42,784 | - | - |
| Grazing Land Protection | - | - | - | 123,147 | - |
| Animal Waste Management Systems | - | - | - | - | 71 |
| Yield Reserve | 0 | 0 | 0 | - | - |
| Carbon Sequestration | 0 | 0 | - | - | - |
| Excess Manure Removal | - | - | - | - | 0 |
| Conservation Tillage | -7,282 | - | - | - | - |

| Forest | Forest Land |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 17,793 |

| Onsite Wastewater Management Systems | Existing Systems | New Systems |
|---|---|---|
| Denitrification w/ Pumping[3] | 0 | 237 |

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.

2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.

3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

## Exhibit E-4: Tier 3 BMP Scenario: Delaware

| BMP | Number of Acres[1] | | | |
|---|---|---|---|---|
| **Urban** | **Pervious** | **Impervious** | **Ultra** | **Mixed Open** |
| Forest Buffers | 172 | - | - | 169 |
| Grass Buffers | 395 | - | - | - |
| Environmental Site Design / Low-Impact Dev. | 862 | 322 | - | - |
| Storm Water Retrofits | 3,472 | 1,041 | 0 | - |
| Storm Water Management on New Dev. | 862 | 322 | - | - |
| Nutrient Management | 14,314 | - | - | 82,884 |
| Urban Land Conversion | 0 | 0 | - | - |
| Forest Conservation | 0 | 0 | - | - |

| **Agriculture[2]** | **High Till** | **Low Till** | **Hay** | **Pasture** | **Manure** |
|---|---|---|---|---|---|
| Forest Buffers | 333 | 4,230 | 173 | 283 | - |
| Grass Buffers | 256 | 2,539 | - | - | - |
| Wetland Restoration | 5 | 184 | 4 | 0 | - |
| Retirement of Highly Erodible Land | 2,528 | 17,930 | 601 | - | - |
| Tree Planting | 0 | 0 | - | 0 | - |
| Farm Plans | 10,730 | 76,242 | 18,391 | 3,153 | - |
| Cover Crops | 11,463 | 81,666 | - | - | - |
| Stream Protection w/ Fencing | - | - | - | 839 | - |
| Stream Protection w/o Fencing | - | - | - | 70 | - |
| Nutrient Management Plan Implementation | 7,919 | 70,602 | 18,213 | - | - |
| Grazing Land Protection | - | - | - | 2,252 | - |
| Animal Waste Management Systems | - | - | - | - | 5 |
| Yield Reserve | 4,599 | 32,675 | 7,882 | - | - |
| Carbon Sequestration | 2,705 | 19,221 | - | - | - |
| Excess Manure Removal | - | - | - | - | 84,301 |
| Conservation Tillage | -8,225 | - | - | - | - |

| **Forest** | **Forest Land** |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 873 |

| **Onsite Wastewater Management Systems** | **Existing Systems** | **New Systems** |
|---|---|---|
| Denitrification w/ Pumping[3] | 178 | 3,183 |

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.

2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.

3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

## Exhibit E-4: Tier 3 BMP Scenario: District of Columbia

**BMP** **Number of Acres[1]**

| Urban | Pervious | Impervious | Ultra | Mixed Open |
|---|---|---|---|---|
| Forest Buffers | 44 | - | - | 43 |
| Grass Buffers | 101 | - | - | - |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | - | - |
| Storm Water Retrofits | 3,454 | 0 | 3,715 | - |
| Storm Water Management on New Dev. | 0 | 0 | - | - |
| Nutrient Management | 12,952 | - | - | 515 |
| Urban Land Conversion | 0 | 0 | - | - |
| Forest Conservation | 0 | 0 | - | - |

| Agriculture[2] | High Till | Low Till | Hay | Pasture | Manure |
|---|---|---|---|---|---|
| Forest Buffers | 0 | 0 | 0 | 0 | - |
| Grass Buffers | 0 | 0 | - | - | - |
| Wetland Restoration | 0 | 0 | 0 | 0 | - |
| Retirement of Highly Erodible Land | 0 | 0 | 0 | - | - |
| Tree Planting | 0 | 0 | - | 0 | - |
| Farm Plans | 0 | 0 | 0 | 0 | - |
| Cover Crops | 0 | 0 | - | - | - |
| Stream Protection w/ Fencing | - | - | - | 0 | - |
| Stream Protection w/o Fencing | - | - | - | 0 | - |
| Nutrient Management Plan Implementation | 0 | 0 | 0 | - | - |
| Grazing Land Protection | - | - | - | 0 | - |
| Animal Waste Management Systems | - | - | - | - | 0 |
| Yield Reserve | 0 | 0 | 0 | - | - |
| Carbon Sequestration | 0 | 0 | - | - | - |
| Excess Manure Removal | - | - | - | - | 0 |
| Conservation Tillage | 0 | - | - | - | - |

| Forest | Forest Land |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 0 |

| Onsite Wastewater Management Systems | Existing Systems | New Systems |
|---|---|---|
| Denitrification w/ Pumping[3] | 32 | 188 |

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.

2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.

3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

# Exhibit E-4: Tier 3 BMP Scenario: Maryland

**BMP** **Number of Acres[1]**

| Urban | Pervious | Impervious | Ultra | Mixed Open |
|---|---|---|---|---|
| Forest Buffers | 5,946 | - | - | 11,524 |
| Grass Buffers | 13,697 | - | - | - |
| Environmental Site Design / Low-Impact Dev. | 30,983 | 14,271 | - | - |
| Storm Water Retrofits | 140,422 | 67,002 | 1,846 | - |
| Storm Water Management on New Dev. | 30,983 | 14,271 | - | - |
| Nutrient Management | 573,056 | - | - | 629,729 |
| Urban Land Conversion | 19,181 | 7,689 | - | - |
| Forest Conservation | 0 | 0 | - | - |

| Agriculture[2] | High Till | Low Till | Hay | Pasture | Manure |
|---|---|---|---|---|---|
| Forest Buffers | 4,163 | 30,526 | 5,833 | 9,572 | - |
| Grass Buffers | 3,571 | 24,562 | - | - | - |
| Wetland Restoration | 1,378 | 7,248 | 1,274 | 0 | - |
| Retirement of Highly Erodible Land | 19,011 | 102,747 | 18,278 | - | - |
| Tree Planting | 0 | 0 | - | 0 | - |
| Farm Plans | -281,734 | 26,207 | 143,400 | -17,280 | - |
| Cover Crops | 40,681 | 436,543 | - | - | - |
| Stream Protection w/ Fencing | - | - | - | 27,628 | - |
| Stream Protection w/o Fencing | - | - | - | 2,183 | - |
| Nutrient Management Plan Implementation | -301,971 | -147,228 | 54,284 | - | - |
| Grazing Land Protection | - | - | - | 89,961 | - |
| Animal Waste Management Systems | - | - | - | - | 106 |
| Yield Reserve | 38,721 | 203,325 | 86,064 | - | - |
| Carbon Sequestration | 22,777 | 119,603 | - | - | - |
| Excess Manure Removal | - | - | - | - | -2,758 |
| Conservation Tillage | -48,788 | - | - | - | - |

| Forest | Forest Land |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 23,698 |

| Onsite Wastewater Management Systems | Existing Systems | New Systems |
|---|---|---|
| Denitrification w/ Pumping[3] | 3,187 | 32,258 |

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.

2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.

3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

# Exhibit E-4: Tier 3 BMP Scenario: New York

**BMP** **Number of Acres[1]**

| Urban | Pervious | Impervious | Ultra | Mixed Open |
|---|---|---|---|---|
| Forest Buffers | 1,445 | - | - | 1,427 |
| Grass Buffers | 3,329 | - | - | - |
| Environmental Site Design / Low-Impact Dev. | 931 | 1,024 | - | - |
| Storm Water Retrofits | 27,565 | 13,499 | 0 | - |
| Storm Water Management on New Dev. | 931 | 1,024 | - | - |
| Nutrient Management | 104,765 | - | - | 448,885 |
| Urban Land Conversion | 0 | 0 | - | - |
| Forest Conservation | 0 | 0 | - | - |

| Agriculture[2] | High Till | Low Till | Hay | Pasture | Manure |
|---|---|---|---|---|---|
| Forest Buffers | 1,592 | 3,076 | 8,120 | 3,623 | - |
| Grass Buffers | 1,857 | 3,588 | - | - | - |
| Wetland Restoration | 0 | 0 | 0 | 0 | - |
| Retirement of Highly Erodible Land | 5,107 | 18,883 | 24,688 | - | - |
| Tree Planting | 0 | 0 | - | 0 | - |
| Farm Plans | 39,750 | 76,230 | 165,386 | 125,068 | - |
| Cover Crops | 42,589 | 81,675 | - | - | - |
| Stream Protection w/ Fencing | - | - | - | 37,351 | - |
| Stream Protection w/o Fencing | - | - | - | 3,113 | - |
| Nutrient Management Plan Implementation | 12,429 | 42,458 | 84,339 | - | - |
| Grazing Land Protection | - | - | - | 85,190 | - |
| Animal Waste Management Systems | - | - | - | - | 467 |
| Yield Reserve | 9,560 | 18,582 | 40,871 | - | - |
| Carbon Sequestration | 10,021 | 19,218 | - | - | - |
| Excess Manure Removal | - | - | - | - | 0 |
| Conservation Tillage | 87,226 | - | - | - | - |

| Forest | Forest Land |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 54,098 |

| Onsite Wastewater Management Systems | Existing Systems | New Systems |
|---|---|---|
| Denitrification w/ Pumping[3] | 1,109 | 5,960 |

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

## Exhibit E-4: Tier 3 BMP Scenario: Pennsylvania

| BMP | Number of Acres[1] | | | |
|---|---|---|---|---|
| **Urban** | **Pervious** | **Impervious** | **Ultra** | **Mixed Open** |
| Forest Buffers | 6,984 | - | - | 24,244 |
| Grass Buffers | 16,088 | - | - | - |
| Environmental Site Design / Low-Impact Dev. | 2,272 | 3,623 | - | - |
| Storm Water Retrofits | 103,404 | 56,728 | 0 | - |
| Storm Water Management on New Dev. | 2,272 | 3,623 | - | - |
| Nutrient Management | 391,174 | - | - | 1,224,540 |
| Urban Land Conversion | 3,621 | 1,811 | - | - |
| Forest Conservation | 0 | 0 | - | - |

| **Agriculture[2]** | **High Till** | **Low Till** | **Hay** | **Pasture** | **Manure** |
|---|---|---|---|---|---|
| Forest Buffers | 10,011 | 32,328 | 43,233 | 12,448 | - |
| Grass Buffers | 11,670 | 37,817 | - | - | - |
| Wetland Restoration | 284 | 1,398 | 894 | 0 | - |
| Retirement of Highly Erodible Land | 26,170 | 142,777 | 112,749 | - | - |
| Tree Planting | 0 | 0 | - | 0 | - |
| Farm Plans | -411,629 | 481,804 | 845,463 | 284,020 | - |
| Cover Crops | 217,537 | 698,013 | - | - | - |
| Stream Protection w/ Fencing | - | - | - | 120,271 | - |
| Stream Protection w/o Fencing | - | - | - | 9,954 | - |
| Nutrient Management Plan Implementation | -464,123 | 482,723 | 531,400 | - | - |
| Grazing Land Protection | - | - | - | 234,634 | - |
| Animal Waste Management Systems | - | - | - | - | 2,031 |
| Yield Reserve | 66,818 | 211,831 | 227,743 | - | - |
| Carbon Sequestration | 51,185 | 164,238 | - | - | - |
| Excess Manure Removal | - | - | - | - | 220,368 |
| Conservation Tillage | 301,933 | - | - | - | - |

| **Forest** | **Forest Land** |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 206,552 |

| **Onsite Wastewater Management Systems** | **Existing Systems** | **New Systems** |
|---|---|---|
| Denitrification w/ Pumping[3] | 4,026 | 13,457 |

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

## Exhibit E-4: Tier 3 BMP Scenario: Virginia

**BMP** **Number of Acres[1]**

| Urban | Pervious | Impervious | Ultra | Mixed Open |
|---|---|---|---|---|
| Forest Buffers | 13,342 | - | - | 13,171 |
| Grass Buffers | 30,733 | - | - | - |
| Environmental Site Design / Low-Impact Dev. | 17,616 | 18,160 | - | - |
| Storm Water Retrofits | 214,670 | 95,141 | 2,619 | - |
| Storm Water Management on New Dev. | 17,616 | 18,160 | - | - |
| Nutrient Management | 824,828 | - | - | 1,331,151 |
| Urban Land Conversion | 14,319 | 5,571 | - | - |
| Forest Conservation | 0 | 0 | - | - |

| Agriculture[2] | High Till | Low Till | Hay | Pasture | Manure |
|---|---|---|---|---|---|
| Forest Buffers | 3,460 | 18,842 | 25,290 | 28,143 | - |
| Grass Buffers | 3,818 | 18,783 | - | - | - |
| Wetland Restoration | 299 | 1,633 | 1,951 | 0 | - |
| Retirement of Highly Erodible Land | 11,004 | 65,910 | 76,856 | - | - |
| Tree Planting | 0 | 0 | - | 0 | - |
| Farm Plans | -127,599 | 202,200 | 515,800 | 814,169 | - |
| Cover Crops | 44,574 | 311,176 | - | - | - |
| Stream Protection w/ Fencing | - | - | - | 259,909 | - |
| Stream Protection w/o Fencing | - | - | - | 20,835 | - |
| Nutrient Management Plan Implementation | -94,658 | 80,973 | 258,073 | - | - |
| Grazing Land Protection | - | - | - | 665,509 | - |
| Animal Waste Management Systems | - | - | - | - | 344 |
| Yield Reserve | 21,847 | 107,610 | 164,381 | - | - |
| Carbon Sequestration | 15,936 | 78,977 | - | - | - |
| Excess Manure Removal | - | - | - | - | 298,035 |
| Conservation Tillage | -17,781 | - | - | - | - |

| Forest | Forest Land |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 61,136 |

| Onsite Wastewater Management Systems | Existing Systems | New Systems |
|---|---|---|
| Denitrification w/ Pumping[3] | 3,867 | 22,519 |

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

## Exhibit E-4: Tier 3 BMP Scenario: West Virginia

**BMP** **Number of Acres[1]**

| Urban | Pervious | Impervious | Ultra | Mixed Open |
|---|---|---|---|---|
| Forest Buffers | 590 | - | - | 582 |
| Grass Buffers | 1,359 | - | - | - |
| Environmental Site Design / Low-Impact Dev. | 1,017 | 640 | - | - |
| Storm Water Retrofits | 9,483 | 4,429 | 0 | - |
| Storm Water Management on New Dev. | 1,017 | 640 | - | - |
| Nutrient Management | 37,087 | - | - | 152,548 |
| Urban Land Conversion | 0 | 0 | - | - |
| Forest Conservation | 0 | 0 | - | - |

| Agriculture[2] | High Till | Low Till | Hay | Pasture | Manure |
|---|---|---|---|---|---|
| Forest Buffers | 164 | 778 | 5,595 | 9,781 | - |
| Grass Buffers | 168 | 974 | - | - | - |
| Wetland Restoration | 0 | 0 | 0 | 0 | - |
| Retirement of Highly Erodible Land | 759 | 4,404 | 14,963 | - | - |
| Tree Planting | 0 | 0 | - | 0 | - |
| Farm Plans | -4,759 | 8,002 | 57,659 | 138,115 | - |
| Cover Crops | 456 | 16,689 | - | - | - |
| Stream Protection w/ Fencing | - | - | - | 97,255 | - |
| Stream Protection w/o Fencing | - | - | - | 8,051 | - |
| Nutrient Management Plan Implementation | -588 | 8,239 | 41,361 | - | - |
| Grazing Land Protection | - | - | - | 187,528 | - |
| Animal Waste Management Systems | - | - | - | - | 119 |
| Yield Reserve | 986 | 5,115 | 23,336 | - | - |
| Carbon Sequestration | 907 | 4,642 | - | - | - |
| Excess Manure Removal | - | - | - | - | 0 |
| Conservation Tillage | -9,017 | - | - | - | - |

| Forest | Forest Land |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 19,770 |

| Onsite Wastewater Management Systems | Existing Systems | New Systems |
|---|---|---|
| Denitrification w/ Pumping[3] | 372 | 2,365 |

Source: Based on the CBP Watershed Model. Calculated by subtracting Progress 2000 from the Tier scenario, except when a negative result would occur for practices with large upfront costs (e.g., forest buffers).

Notes: A dash (-) indicates the BMP is not applicable; a zero indicates zero implementation.

1. Units are manure acres for Animal Waste Management Systems, wet tons per year for Excess Manure Removal, number of systems for Onsite System Denitrification, and land acres for all other BMPs.
2. Negative values reflect the conversion of land from agricultural to other use, or from one agricultural land type to another.
3. BMP applies to 0% of existing and new systems in Tier 1; 0% of existing systems and 10% of new systems in Tier 2; and 1% of existing systems and 100% of new systems in Tier 3.

The following sections document the derivation of unit costs for the practices contained in Exhibit E-4. The unit costs are annual implementation costs in constant 2001 dollars. The measurement units match the BMP quantities, which are generally expressed in acres affected each year. Therefore, most of the unit costs represent an average or typical cost per acre per year ($/ac/yr). The per-acre format is necessary to estimate annual costs for the different control scenarios from the Chesapeake Bay Program's watershed model. Annual costs include annualized capital expenditures (e.g., for infrastructure) and annual operating and maintenance costs.

### 2.2.1 Agriculture

Cost-sharing is commonly used to encourage implementation of agricultural BMPs. These programs provide four types of financial assistance: a cost offset for upfront BMP implementation expenses (**Exhibit E-5**), annual land rent (**Exhibit E-6**), annual maintenance payments, and one-time incentive payments.[2] The CBP used the upfront cost shares to offset initial BMP implementation costs, and assumed that the annual rental revenue completely offsets any net revenue losses the farmer might incur because of changes in production practices or foregone production. Thus, where the actual net revenue loss is less than the annual rental payment, costs to the farmer are overestimated. Annual maintenance and one-time incentive payments are subtracted from farmer costs, but other costs of maintaining BMPs (O&M) are generally not eligible for cost-share.[3]

[2] Conservation Reserve Enhancement Programs in DE, MD, PA, VA, and WV, and the draft Program for the Susquehanna watershed in NY, provide annual maintenance payments of $5/ac/yr for a 10- to 15-year contract for forest and grass riparian buffers, wetland restoration, retirement of highly erodible land, tree planting, and farm plans (soil conservation and water quality plans). In Maryland, the CREP program also offers a one-time incentive payment of $100/ac for forest and grass riparian buffers, wetland restoration, and retirement of highly erodible land. In Virginia, the CREP program offers a one-time incentive payment of $50 or $75/ac (for 10- or 15-year contracts, respectively) for forest and grass riparian buffers, wetland restoration, retirement of highly erodible land, tree planting, and farm plans (soil conservation and water quality plans). The cost estimates reflect an average incentive payment of $62.50/ac (i.e., the average of $50/ac and $75/ac) in Virginia.

[3] Farms that implement BMPs as a result of regulations imposed by the CAFO Rule or CZARA are eligible for funding from Federal and State cost sharing programs.

## Exhibit E-5: Capital Cost Funding for Agricultural BMPs from Known State and Federal Programs[1]

| Practice | DE | MD | NY | PA | VA | WV |
|---|---|---|---|---|---|---|
| Forest Buffers | 87.5% | 87.5% | 87.5% | 100% | 75% | 75% |
| Grass Buffers | 87.5% | 87.5% | 87.5% | 100% | 75% | 75% |
| Wetland Restoration | 87.5% | 87.5% | 87.5% | 100% | 75% | 75% |
| Retire Erodible Land | 87.5% | 87.5% | 87.5% | 100% | 75% | 75% |
| Tree Planting | 87.5% | 87.5% | 75% | 75% | 75% | 75% |
| Nutrient Management Plan | $10/ac/ 3yrs[2] | $6/ac/ 3yrs[2] | 87.5% | 80% | $3/ac/yr[2] | 75% |
| Cover Crops | 75% | $20/ac/yr[2] | 87.5% | $15/ac/yr[2] | 75% | 75% |
| Stream Protection w/ Fence | 75% | 87.5% | 87.5% | 100% | 75% | 75% |
| Stream Protection w/o Fence | 75% | 87.5% | 87.5% | 80% | 75% | 75% |
| Grazing Land Protection | 75% | 87.5% | 87.5% | 80% | 75% | 75% |
| Animal Waste Management | 75% | 87.5% | 87.5% | 80% | 75% | 75% |

Sources: DDA (2002a), MDA (2000), NY Soil and Water Conservation Committee (no date), PA DEP (1998, 2001), USDA-FSA (1997a, 1997b, 1999a, 1999b, 2000a, 2000b, 2002a, 2002b), USDA-NRCS (no date, 1998, 2001a, 2001b, 2001c, 2001d, 2001e, 2001f), VA DCR (2001), personal communication with Gary Smith (PA NRCS, April 2002), Cedric Karper (PA DEP, May 2002), John Long (MD NRCS, May 2002), Mark Waggoner (MD NRCS, May 2002), Michelle Esch (MACS, May 2002), Lester Stillson (DE NRCS, April 2002), Ken Carter (VA NRCS, May 2002), Dana Bayless (VA Division of Conservation and Recreation, April 2002), Teresa Koon (WV Soil Conservation Agency, May 2002), Rick Heaslip (WV NRCS, April 2002), and Emily Dodd (NY State Department of Agriculture and Markets, May 2002 and November 2002).

1. Percentage rates reflect a percentage of actual installation (capital) costs.

2. Certain programs in some States pay a fixed rate rather than a percentage of costs: in DE (two programs pay $5/ac each for a 3-year nutrient management plan); in MD (MACS pays $6/ac for a 3-year nutrient management plan, and $20/ac/yr for cover crops); in PA (PA EQIP pays $15/ac/yr for cover crops); and in VA (VACS pays $3/ac/yr for nutrient management plans).

**Exhibit E-6: Annual Funding from Identified Programs for Land Rental Associated with Agricultural BMPs, as a Percent of USDA Dryland Rental Rate for County[1]**

| Practice | DE | MD | NY[2] | PA | VA | WV[2] |
|---|---|---|---|---|---|---|
| Forest Buffers | 250%[3] | 190% | 145% | 220% | 240%[4] | 120% |
| Grass Buffers | 170%[5] | 170% | 145% | 220% | 240%[4] | 120% |
| Wetland Restoration[6] | 125%[5] | 125% | 145% | 175% | 195%[4] | 75% |
| Retire Erodible Land | 100% | 150% | 145% | 175% | 220%[4] | 100% |
| Tree Planting | 230%[3] | 100% | 145% | 100% | 100% | 100% |

Sources: USDA-NRCS (no date); USDA-FSA (2002b, 2002c, 2000a, 2000b, 1999a, 1999b, 1997b); personal communication with Emily Dodd (NY State Department of Agriculture and Markets, November 2002).

1. Reflects rental payments from the USDA CRP (or WRP, for wetland restoration) and State CREP programs. Rental payments are made only for BMPs that result in taking land out of agricultural production. Rates shown do not include annual maintenance or one-time incentive payments. Rental payments are also made for certain practices associated with farm plans (see Section 2.2.1.6).
2. NY CREP program for the Bay watershed is pending USDA approval; percentages shown are from NY State draft program documents.
3. The annual rental payment cannot exceed $150 per acre.
4. The annual rental payment cannot exceed $100 per acre.
5. The annual rental payment cannot exceed $110 per acre.
6. USDA WRP rental payment can be 0%, 75% or 100% of dryland rental rate, depending on length of contract; the analysis uses 75%, which corresponds to a 30-year contract.

The funding percentages listed in Exhibits E-5 and E-6 reflect the Conservation Reserve Program (CRP) and Conservation Reserve Enhancement Program (CREP) in all States, and Environmental Quality Incentive Program (EQIP) cost shares for DE, MD, PA, VA, and WV.[4] In addition, the exhibits include cost sharing from the Maryland Agricultural Water Quality Cost-Share Program (MACS) and Wildlife Habitat Incentives Program (WHIP) in Maryland; the Virginia Agricultural BMP Cost-Share Program (VACS) in Virginia; the Delaware Department of Agriculture Nutrient Management Cost Share Program in Delaware; the NY Agricultural Nonpoint Source Abatement and Control Program (ANPSACP); the Pennsylvania Department of Environmental Protection (DEP) Chesapeake Bay Financial Assistance Funding Program and Streambank Fencing Program in Pennsylvania; and the West Virginia Potomac Headwaters Water Quality Project (implemented under Public Law 534) in West Virginia.

The funding levels shown indicate the potential cost share if all programs are fully funded at current rates. In most cases, farmers are eligible for funding from more than one program (e.g., installation costs for riparian forest buffers in Maryland can be cost-shared under EQIP at 75%, CRP/CREP at 87.5%, MACS at 87.5%, and WHIP at 75%). Although most programs require landowners to contribute a portion of installation costs, certain programs, such as the Pennsylvania DEP Stream Bank Fencing Program, provide 100% funding for installation of selected BMPs.

Exhibit E-5 does not reflect changes to the Wetlands Reserve Program (WRP), CRP, or EQIP in the 2002 Farm Bill, including an increase in the possible EQIP cost-share percentage for limited-resource farmers to 90% (from 75%) for eligible BMPs. Although relatively few small farmers meet the definition of a limited-resource farmer, they are likely to be the ones least able to pay additional BMP costs. Also, Virginia, Maryland, and possibly other States have additional rewards for farmers implementing BMPs in the form of tax credits. The estimates below do not incorporate tax credits, which means that some estimates will overstate farmer costs.

The annual cost of agricultural BMPs reflects amortized capital costs plus annual O&M payments. Capital costs are commonly paid upfront when a BMP is implemented (i.e., the farmer does not take out a loan). However, to estimate an annual cost for evaluating financial impacts, the CBP amortized capital costs at 5% (instead of assuming no interest cost) to represent an opportunity cost (since farmers typically implement BMPs with profits from a good year, these funds cannot then be saved for a future year). Capital costs are amortized over the typical contract period provided by the cost share programs for each BMP. However, if contract period does not apply (e.g., BMPs not cost shared through the CRP or CREP programs), the annualization period is the estimated useful life of the practice.

Cost estimates for agricultural BMPs are reported in the original dollar year reported in the source studies (where known), as well as in constant 2001 dollars [updated using the USDA

[4] New York is developing a CREP program for portions of the State that will include the Chesapeake Bay watershed. Information cited here is based on draft information provided by Emily Dodd, NY State Soil and Water Conservation Committee, November 2002, and information in USDA-FSA (2002c). Because the agreement has not been finalized, the information used in the analysis is subject to change.

Economic Research Service (ERS) index of prices paid by farmers (USDA-ERS, 2001)]; averages reflect 2001 dollars.

#### *2.2.1.1 Forest Buffers*

In the Watershed Model, forest buffers are 100-foot-wide strips of forest along riparian corridors in both agricultural and urban land. Implementation costs consist of planting tree seedlings in the first year and relatively intensive maintenance in the years immediately following implementation (replacement planting, herbicides or mowing to reduce competition, and plastic tubes to shelter seedlings from herbivory). Costs can also include reductions in net revenue and out-of-pocket expenses to implement the BMP. The variables that drive cost estimates for forest buffers are the costs of seedlings and shelters, and the amount of intensive maintenance in the first years.

The amount of intensive maintenance required on forest buffers is directly related to the degree of establishment desired and, therefore, the reduction efficiency of the practice. However, information on the level of maintenance required for various reduction efficiencies is not available. Therefore, the estimates below reflect the assumption that forest buffers are mowed in the early years to reduce competition, and shelters to reduce herbivory are used on 50% of trees. Four sources (Palone and Todd, 1998, USDA, 1999, Hairston-Strang, 2002, and MDA, 2002b) contain comprehensive estimates of the cost of installation and maintenance, and two additional sources provide less complete information (MD DNR et al., 1996, and VA SNR, 2000). The final cost estimate is based on the first four sources.[5]

**Exhibit E-7** shows cost estimates for individual components of forest buffer installation and maintenance (costs shown reflect constant 2001 dollars, adjusted from the original sources where necessary), and the average cost for each component across sources, where applicable. The costs for the latter two sources (Hairston-Strang, 2002 and MDA, 2002b) are somewhat lower than the costs for the first two sources. One reason for the difference may be that the costs shown for the other two sources are based on an assumption that tree shelters are used on 50% of the trees planted, whereas the costs from the latter two sources are based on surveys of actual implementation costs in Maryland. The average capital cost for installation among the four sources is $1,284 per acre.

Hairston-Strang (2002) indicates that a representative maintenance schedule for the first few years of establishment would be to mow three times per year for three years, and to spray herbicides for weed control once. Based on this, the CBP calculated maintenance costs as equal to nine times the average mowing cost ($153 per acre total) plus the average cost for spraying herbicides ($80 per acre total), or $233 per acre. The overall cost for installation and maintenance, therefore, is $1,517 per acre.

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[5] Of the less documented sources, MD DNR et al. (1996) indicates a capital cost of $480/ac/yr ($534 in 2001 dollars) for planting and establishment, which is $60/ac/yr annualized at 5% over 12 years. VA SNR (2000) indicates a cost of $230/ac/yr for the practice ($232 in 2001 dollars), but does not specify service life, interest rate, or what cost components are included.

**Exhibit E-7: Cost Estimates ($/acre) for Riparian Forest Buffers[1]**

| Component | Palone & Todd (1998) | USDA (1999) | Hairston-Strang (2002)[3] | MDA (2002b)[4] | Average Cost |
|---|---|---|---|---|---|
| Site preparation | 13 | nd | 1,000 | 812 | 1,284 |
| Planting and replacement planting | 616 | 613 | | | |
| Tree shelters[2] | 1,511 | 528 | | | |
| Initial grass buffer for immediate soil protection | nd | 42 | | | |
| Mowing ($/time) | 13 | 8 | 30 | nd | 17 |
| Herbicide ($/time) | 60 | nd | 100 | nd | 80 |

nd = No data. Costs are one-time installation costs unless otherwise noted.
1. All costs shown are in constant 2001 dollars, updated from original study estimates using the USDA/ERS index for prices paid by farmers (USDA-ERS, 2001), and reflect per-acre costs.
2. Costs shown for tree shelters reflect installation of shelters on 50% of trees planted.
3. Costs shown are an average of a representative sample of actual costs for installing forest buffers in different regions in Maryland.
4. Costs shown are average practice costs in Maryland for 2001-2002 according to the Maryland Agricultural Water Quality Cost-Share (MACS) program.

The potential service life for a forest buffer may be on the order of 75 years (MD DNR et al., 1996). However, as stated above, to estimate financial impacts, capital costs are annualized over contract periods. (As a result, impacts in future years will be lower by the amount of the capital cost if the service life of the practice exceeds the contract period). CREP offers 10- and 15-year contracts for forest buffers, and most landowners choose 15-year contracts. The historical practices of the Conservation Reserve Program suggest that farmers will likely be able to extend contracts for 10 additional years. Therefore, capital costs are annualized over 25 years.

Annualizing the total installation and early maintenance costs of $1,517 at 5% over 25 years gives an annualized capital cost of $108 per acre, of which 85% is installation cost. Cost-sharing is available for the installation costs at rates ranging from 75% to 100%. In addition, CREP programs offer annual maintenance payments of $5/ac/yr. One-time incentive payments are also available in Maryland and Virginia, and Maryland also offers an additional signup bonus. Thus, the net farmer costs for forest buffers range from -$8/ac/yr (i.e., a net revenue gain) to $34/ac/yr.

In addition to the implementation cost, there is an opportunity cost associated with taking land out of production. In some cases, land bordering streams or rivers is more productive than the farm or field average because of higher soil fertility associated with the flood plain, but in many cases riparian borders are considered marginal land because of greater erosion, steep slopes, poor drainage, periodic flooding, and low soil fertility (Palone and Todd, 1998; USDA, 1999). As stated above, the land rental payment from CREP likely offsets any net revenue losses from changes in land use resulting from this practice.

### *2.2.1.2 Grass Buffers*

In the Watershed Model, grass buffers are 100-foot-wide strips of grass along riparian corridors. Establishment costs include purchase of seed, fertilizer and lime, initial planting, and mowing to maintain the practice and to prevent grasses from going to seed, in addition to opportunity costs from taking land out of production. Maintenance costs include mowing. An important consideration in calculating a cost for grass buffers is whether warm-season grasses (WSG) or cool-season grasses (CSG) are used. WSG seed is more expensive, but the grasses grow better in drought and provide better wildlife habitat. CSG seed is cheaper, sod establishment is faster, and sediment load reduction is generally greater because the plants are more active in spring and fall (Nakao et al., 1999). Data on the relative use of cool- and warm-season grasses are not available, so costs are based on equal use of cool- and warm-season grasses.

Several sources provide cost estimates for grass buffers. The CBP used estimates from Nakao et al. (1999) and Yeh and Sohngen (1999) because they itemize costs for seed, fertilizer and lime, and planting costs, and because they distinguish the costs of warm season and cool season grasses.[6] **Exhibit E-8** shows the resulting cost estimates for each component of the BMP.

**Exhibit E-8: Grass Buffer BMP Costs ($/acre)[1]**

| Component | Estimated Cost (CSG)[2] | Estimated Cost (WSG)[3] |
|---|---|---|
| Seed | $21 | $120[4] |
| Fertilizer and lime | $38 | $38 |
| Labor and equipment[5] | $23 | $23 |
| Total cost | $82 | $181 |

CSG = Cool-season grass
WSG = Warm-season grass
1. All costs shown are in 2001 dollars, updated from current dollars using the USDA/ERS index for prices paid by farmers (USDA-ERS, 2001), and reflect costs for installation.
2. From Nakao et al. (1999).
3. From Sohngen and Yeh (1999).
4. Based on average seed costs for switchgrass ($40/ac), big bluestem ($150/ac), and indiangrass ($160/ac).
5. Based on costs for no-till planting.

The average cost for the installation of grass buffers, based on 50% implementation of CSG and 50% implementation of WSG buffers, is $132/acre. Annualized at 5% over 10 years (the minimum term of a CRP/CREP contract), installation costs are $17/ac/yr.

[6] Data from the MACS program, indicating a maximum cost-share amount of $200/acre for CSG buffers and $400/acre for WSG buffers, are not included in the estimates because these represent maximum payment amounts rather than practice costs. The higher maximum payments likely reflect the potential for site preparation costs to be much greater than average.

Possible O&M costs for grass buffers consist of mowing. Four sources for mowing costs are reflected in the estimate for this practice: USDA, 1999 ($8/ac/time in 2001 dollars), Palone and Todd, 1998 ($13/ac/time in 2001 dollars), Hairston-Strang, 2002 ($30/ac/time), and Nakao et al., 1999 ($25/ac/time in 2001 dollars). The average cost for mowing from these sources is $19/ac/time. If mowing is necessary to maintain buffer strips, then it would need to happen two to three times per year (Hairston-Strang, 2002; Nakao et al., 1999). In locations where topography allows hay harvesting, revenue from haying could offset mowing costs. For instance, Nakao et al. (1999) found that net revenues from haying filter strips in Ohio (i.e., revenue from hay less costs of cutting and baling) averaged $91 per acre.+

Some cost-share programs do not permit grasses to be harvested for hay. However, this may refer to the regular harvest of grasses down to stubble, which would reduce the capacity of a grass buffer to trap nutrients and sediment as it is designed to do. If grasses must be mowed, then the clippings should be removed from the buffer so that they do not enter water bodies and contribute nutrients. Even if the grass is mowed too high to be sold for hay, it could be used on the farm as bedding, feed, mulch or fertilizer. In addition, some native warm-season grasses may not need to be mowed. A mowing cost is not currently included in the cost estimate. Although costs for some areas may be higher if mowing is necessary and the cost is not offset by using the clippings, costs for some areas may be lower than the $17/ac/yr estimate because it is based on average seed costs for three different warm-season grasses; if switchgrass is used (by far the cheapest of the three), actual costs could be substantially lower. The installation cost accounts for 100% of the total annual cost of $17/ac/yr and, therefore, installation cost-sharing applies to 100% of the total cost.

The annual rental payment for this BMP ranges from 120% to 240% of the dryland rental rate across States. As stated above, this likely offsets any net revenue losses from changes in land use and, therefore, the cost of the BMP is out-of-pocket expenses less cost-share funding for installation of the buffer. Cost-sharing ranges from 75% to 100% of implementation costs (see Exhibit E-5), and CREP programs also provide annual maintenance payments of $5/ac/yr. One-time incentive payments are also available in Maryland and Virginia. Thus, net unit costs range from -$13/ac/yr (i.e., a net cost savings) to -$1/ac/yr.

#### *2.2.1.3 Wetland Restoration*

Wetland restoration reverses wetland reclamation, or the draining of wetlands so they can be planted. Significant earth moving may be required (e.g. to plug or fill drainage ditches that were dug in the process of reclamation). O&M costs include inspecting embankments and structures for damage or erosion, and management of unwanted vegetation (USDA-NRCS, 1998).

Three sources contain cost estimates for this practice. The USDA Farm Service Agency's Practice Summaries for Active CREP Contracts for States with CREP programs (USDA-FSA, 2002a) reports wetland restoration cost-shares for Delaware (2001-2002), Maryland (1998-2002), Pennsylvania (2001-2002), and Virginia (2001-2002). The average cost-share amount per acre for these States is $915 (in 2001 dollars), and represents cost-share for installation but not O&M costs. Assuming that average cost-share is 75% and O&M costs are 3% of total initial capital

costs (USDA-SCS, 1980 in NCSU, 1982 reports O&M for permanent vegetative cover on critical areas, a comparable BMP, is 3% of initial capital costs), the initial capital costs are $1,221/acre and annual O&M costs are $37/acre. Under the Wetlands Reserve Program, contract terms range from 30 years to indefinite. Annualizing the capital cost at 5% over 30 years and adding O&M costs results in an annual cost of $116/ac/yr. Sixty-eight percent of this cost is annualized capital (installation) cost and therefore eligible for cost-share; the remainder is O&M, which is not eligible for cost-share.

Of the other two sources identified, Wetland Science Institute (2000) provides costs for site preparation and materials and planting costs for putting in oak seedlings or seeds, but does not include costs for putting in other species or O&M costs. Average costs for site preparation and materials and planting are $123 per acre ($124 in 2001 dollars), which is very close to the estimates based on actual wetland restoration projects cost-shared by CREP as reported above. The second source (EPA, 1997a) reports average costs for constructed wetlands for controlling urban runoff at between $749 and $20,000 per acre (in current dollars); however, as this source does not elaborate as to what costs are included, how costs are calculated, or how costs in agricultural areas might differ from costs in urban areas, these estimates are not used.

Funding for wetland restoration ranges from 75% to 100% of installation costs (see Exhibit E-5), and CREP programs also provide annual maintenance payments of $5/ac/yr. One-time incentive payments are also available in Maryland and Virginia. Thus, net farmer costs range from $32 to $52/ac/yr. Annual rental rates range from 75% to 195% of the USDA dryland rental rate within a county. As stated above, this annual revenue likely offsets any net revenue losses attributable to changes in land use.

#### *2.2.1.4 Retirement of Highly Erodible Land (HEL)*

In the Watershed Model, this practice consists of converting agricultural land to the mixed open land use category. Although either grass or trees may be used as a cover, in the Watershed Model this practice is modeled as a conversion to mixed open land use, and the load from mixed open land use is closer to the load from hayland than the load from forest. Thus, the cost estimates used reflect the costs of establishing grass cover. Additional costs accrue as a result of foregone net revenues from crop plantings.

Several sources contain cost estimates ranging from $9/ac/yr to $157/ac/yr (in 2001 dollars) for permanent vegetative cover on critical areas (VA SNR, 2000; MD DNR, 1996; VA DEQ, 1993; EPA, 1997a; and Camacho, 1992). The estimates from these sources reflect different assumptions about what type of cover is used, service life, O&M costs, and net revenue impacts, among others. Documentation on most of the sources is quite sparse, so there is little basis for comparison.

This practice could entail planting of grass or forest cover, and is therefore similar to the riparian grass and forest buffer BMPs. To reflect the way this practice is modeled in the Watershed Model, the establishment cost reflects the cost of grass buffers, $17/ac/yr. The implementation cost share, which ranges from 75% to 100% across States, annual maintenance payments of

$5/ac/yr from CREP programs, and one-time incentive payments available in Maryland and Virginia, reduce net implementation costs to - $13/ac/yr to - $1/ac/yr. Furthermore, as stated above, annual revenues per acre that equal 100% to 220% of the USDA dryland rental rate across States (Exhibit E-6) likely offset any revenue loss associated with land retirement.

#### *2.2.1.5 Tree Planting*

In the Watershed Model, the tree planting BMP occurs in any area except along a river or stream, and is modeled as a land use conversion from agricultural or urban land to forest. Because this BMP is very similar to forest buffers, the unit cost of $108/ac/yr for forest buffers applies. As with forest buffers, the cost includes a combination of mowing and herbicide sprays to reduce competition in the initial years.

The cost-share for implementation ranges from 75% to 87.5% across States, and CREP programs offer annual maintenance payments of $5/ac/yr. One-time incentive payments are also available in Virginia. Thus, net farmer costs range from $23 to $34/ac/yr. The Federal CRP program and State CREP programs offer annual payments ranging from 100% to 230% of the USDA dryland rental rate (Exhibit E-6) to offset net income losses from land planted to trees, and this rental payment likely offsets any net revenue losses.

#### *2.2.1.6 Farm Plans/Soil Conservation and Water Quality Plans*

In the Watershed Model, farm plans represent comprehensive management plans according to which structural or management practices are implemented to bring total soil loss to an acceptable level (the specific level depends on local conditions). Specific practices that may be implemented include contour farming, strip cropping, terrace systems, diversions, and grassed waterways. Farm plans also frequently include conservation tillage, nutrient management plans, cover crops, and other practices that are included as separate BMPs in the Watershed Model.

Several sources provide cost estimates for individual practices that may be implemented in accordance with a farm plan. However, estimating a single per-acre cost is more difficult than for other BMPs because only some of these practices may be used depending on site-specific conditions. The costs in the cost analysis are based on estimates from Camacho (1992), who obtained 14 representative farm plans from State contacts in Pennsylvania, Maryland, and Virginia. These plans include different application rates for the individual practices, and represent plans for different regions in the watershed. Camacho estimated the median cost per acre for the development of plans as well as the practices implemented under the plans, but the costs in his report include some costs from practices included separately in the Watershed Model (such as cover crops and conservation tillage).

To avoid double-counting costs for BMPs that are included separately in the Watershed Model, the CBP calculated an average cost of farm plans using Camacho's data, subtracting the costs of these "duplicated" BMPs. In addition, it differentiated costs for development and implementation of farm plans on hay and pasture land from the costs for plans on cropland, because some practices associated with farm plans would be applied only to one type of land and

not the other. For example, strip-cropping on cropland involves alternating strips of row or grain crops with strips of closer growing crops; the closer growing strips reduce erosion by slowing runoff and capturing soil particles. This practice would not be used in hay production or pasture land because the sod remains intact. After eliminating the "duplicated" BMPs from the representative farm plans in Camacho (1992), the practices for cropland include strip-cropping, contour strip-cropping, contour farming, terraces, diversions, grassed waterways, and crop rotation. For hay and pasture land, the applicable practices are diversions, grassed waterways, terraces, and contour planting.

Costs for the practices implemented according to farm plans may differ depending on topography, since more intensive management may be needed to control soil erosion on sloping or mountainous land than on coastal plain. However, the estimates based on Camacho (1992) for practices associated with farm plans (excluding the costs of the duplicate BMPs) are not significantly different between the two topographic regions ($19/ac/yr on coastal land versus $20/ac/yr in sloping regions, in 2001 dollars). The average cost of the practices associated with farm plans is $19/ac/yr for plans on crop land, and $15/ac/yr on hay and pasture land (in 2001 dollars). These estimates include planning and technical assistance (for the practices associated with the farm plan, although not for the farm plan itself), installation costs, and annual O&M, with installation costs annualized at 10% over the life of the practice (ranging from 5 to 10 years for the individual practices). The CBP re-annualized these costs at a 5% rate over 10 years by backing out the original capital cost (assuming O&M costs equal 5% of the initial capital cost that reflects annualizing at 10% over 10 years). The adjusted estimates are $16/ac/yr for farm plans on cropland and $13/ac/yr on hay and pasture.

These costs do not include the cost of the plan itself. Based on costs for designing nutrient management plans from USDA (1999), the estimated cost for a farm plan is $5 per acre, and the estimated useful life is 10 years (MD DNR et al., 1996). Adding in the resulting annual cost of $0.50 per acre results in an estimated cost of the plan and the practices associated with it of $17/ac/yr on cropland and $13/ac/yr on hay and pasture (the costs for hay and pasture do not appear to change because of rounding). Seventy percent of the costs for the BMP on cropland, and 69% for hay and pasture land, are annualized capital and therefore eligible for cost-share. The annualized capital portion of the cost does not include the cost of the plan itself, since cost-sharing programs generally do not pay for the plan itself but only for the practices associated with it.

Funding for installation of practices associated with farm plans ranges from 75% to 100% over the States, which applies to the 70% of costs that are annualized capital (69% for farm plans on hay and pasture land). Annual maintenance payments of $5/ac/yr are available from CREP programs for certain practices (such as grassed waterways) associated with farm plans. One-time incentive payments for the installation of certain practices are also available in Virginia. However, the CBP did not incorporate maintenance or incentive payments because data are insufficient to identify the proportion of land on which the eligible practices would be implemented. Thus, net farmer costs range from $5 to $8/ac/yr for farm plans on crop land and from $4 to $6/ac/yr for farm plans on hay and pasture. Annual rental payments from CRP and CREP equal to 100%–200% of USDA dryland rental rates by county likely offset any net

revenue losses resulting from land taken out of production or changes in production activity. However, due to a lack of data on how much land is taken out of production as a result of the practices associated with farm plans, cost-share totals do not include these rental payments.

#### *2.2.1.7 Cover Crops*

Cover crops are grasses and legumes planted on cropland in the fall after the main crop is harvested, and killed in the spring before the main crop is planted. In addition to building organic matter and improving nutrient uptake, they reduce soil erosion in late fall, winter, and early spring.

The major costs are purchasing cover crop seed and machinery and labor for planting. Although some estimates of costs include the costs of tillage or herbicide in the spring to kill the cover crop, these costs are not included because they are necessary regardless of whether a cover crop is used (except when spring weather conditions or special management requirements necessitate a separate round of tillage or herbicide for the cover crop). Benefits come from sediment erosion protection and holding nutrients not utilized during the growing season.

Several sources (Mannering et al., 1985; Roberts et al., 1998; VA SNR, 2000; MD DNR et al., 1996; Camacho, 1992; Lichtenberg et al., 1994) report estimates of cover crop costs ranging from $10/ac/yr to $37/ac/yr in current dollars ($12/ac/yr to $49/ac/yr in 2001 dollars). Because of variations in these estimates and sometimes incomplete documentation regarding what costs are included, costs are based on another source (personal communication with Ken Staver, Wye Research and Education Center, Queenstown, MD, May 2002). For a rye cover in a no-till system, Staver estimates seed costs at $12/ac and planting costs at $15/ac.

The resulting cost estimate of $27/ac/yr does not reflect possibly greater costs due to the possibility of an additional herbicide application in the spring, nor does it reflect increased risk (for instance, in a wet spring the need to turn in the cover crop may delay spring planting). However, it also does not reflect potential cost offsets due to improved yields. Yield increases have the potential to make the cover crop pay for itself or generate net revenue. For example, one group of researchers observed an average net revenue increase of $16/ac/yr in no-till corn using vetch, clover, wheat, and pea cover crops because the cover crops increased nutrient uptake and the marginal productivity of nitrogen (Lichtenberg et al., 1994).

Cost-sharing for cover crops in some programs is provided at a fixed dollar rate; other programs pay a percentage of incurred costs. Expressed as a percentage of the estimated cost of $27/ac/yr, rates range from 56% to 87.5%. Thus, the net farmer cost ranges from $3 to $12/ac/yr.

#### *2.2.1.8a Streambank Protection with Fencing*

Streambank protection consists of fencing to keep animals out of streams, alternative water and shade sources in pastures, and practices at stream crossings to reduce soil erosion from hooves and reduce the amount of time animals spend in the water (e.g., culverts or concrete fords at stream crossings). The Watershed Model reports linear fence miles for stream protection as well

as total acreage protected. Ideally, the cost analysis would incorporate the linear fencing data to calculate the cost of fencing and use protected acreage data to estimate the costs of other practices associated with streambank protection. Fence miles is ideal for fence costs, but uninformative for alternative water source costs.

Linear fence cost estimates from U.S. EPA (1997) range from $2,330 to $2,677 per mile (or $2,816 to $3,235 in 2001 dollars, which is $365 to $420 per mile when annualized at 5% over 10 years). Most of these are for permanent fencing (presumably barbed wire) in the West and Midwest; one source notes that less expensive electric fencing may be sufficient for smaller, more intensively managed pastures in the East, but no estimates of these costs are available. The average of the costs identified ($395/mile) may thus overestimate costs if farmers use less expensive fencing.

Two sources provide cost estimates for the suite of practices associated with the streambank protection with fencing BMP. USDA-ASCS (1990, cited in EPA, 1997a) reports average costs ranging from $14/ac/yr in the Pacific region ($18/ac/yr in 2001 dollars) to $76/ac/yr in the Southeast region ($97/ac/yr in 2001 dollars) for stream protection practices that may include, depending on the site, filter strips along streams, channel vegetation, fencing, pipelines, streambank and shoreline protection, field borders, tree planting, troughs or tanks for water in pastures, and stock trails or walkways at stream crossings.[7] MD DNR et al. (1996) reports a cost of $100/ac/yr ($111/ac/yr in 2001 dollars) for a suite of practices called "streambank protection with fencing," based on records from the Maryland Agricultural Water Quality Cost-Share (MACS) Program. Averaging this estimate with the estimate for the Southeast region from USDA-ASCS (1990) results in a cost of $104/ac/yr (2001 dollars) for streambank protection with fencing.

The cost-share for streambank with fencing ranges from 75% to 100%. Of the two sources for costs of streambank protection with fencing, neither breaks out capital from O&M costs. Assuming that capital costs are annualized at 5% over10 years and O&M costs are 5% of the initial capital costs, capital costs represent 72% of the total annual cost. Thus, the cost-share rates apply to 72% of the annual cost estimate. The net farmer cost of streambank protection with fencing ranges from $29 to $48/ac/yr with fencing.

#### *2.2.1.8b Streambank Protection without Fencing*

Only one source identifies costs for streambank protection without fencing. MD DNR et al. (1996) reports costs of $67/ac/yr ($75 in 2001 dollars) based on records from the MACS program. Thus, the estimated cost for streambank protection without fencing is $75/ac/yr.

The cost-share for streambank without fencing ranges from 75% to 87.5%. The sources for costs of streambank protection do not break out capital from O&M costs. Assuming that capital costs

[7] Because this data source includes the costs of filter strips on a proportion of acres, but in this analysis filter strip costs are accounted for separately, using the costs from this source may result in double-counting some costs for acres in the Watershed Model to which both the forest buffer BMP and the streambank protection BMP are applied.

are annualized at 5% over10 years and O&M costs are 5% of the initial capital costs, capital costs represent 72% of the total annual cost. Thus, the cost-share rates apply to 72% of the annual cost estimate. For streambank protection without fencing, net farmer costs range from $28/ac/yr to $35/ac/yr.

#### *2.2.1.9 Nutrient Management Plan Implementation*

In the Watershed Model, this BMP consists of reducing fertilizer application to 130% of a crop's need. Under some plans, fertilizer may also be applied more frequently, in lower amounts that reflect more immediate soil deficiencies and crop needs. Costs result from equipment and labor for soil testing and hiring of a consultant to design the plan, plus the costs of any additional passes over the field to fertilize.

A number of sources provide cost estimates, including Camacho (1992), MD DNR et al. (1996), VA SNR (2000), USDA (1999), and U.S. EPA (2001a). Several sources suggest that landowners can save money by implementing nutrient management plans. Assuming a 3-year useful life for a plan once it is developed, and including the costs of soil testing, implementation, and, in some cases, cost savings and yield increases, net cost estimates range from -$30/ac/yr (i.e., a net cost savings) to $14/ac/yr in current dollars. A simple average is -$1.02/ac/yr, which implies a net cost savings.

However, nutrient management plans that are based on reducing phosphorus applications may require the use of custom fertilizers rather than manure, which would mean that farmers are less likely to be able to use manure generated on the farm (which is where cost savings from nutrient management plans traditionally accrue) (J. Rhoderick, MD Department of Agriculture, personal communication, November, 2002). Four sources provide sufficient cost breakdowns to calculate costs of plan development and implementation alone (i.e., without cost savings). Using a 3-year useful life for the plan, estimates based on these sources (Camacho, 1992; MD DNR et al., 1996; USDA, 1999; U.S. EPA, 2001a) range from $3/ac/yr to $14/ac/yr in 2001 dollars, with an average of $7/ac/yr in 2001 dollars. Thus, the estimated cost is $7/ac/yr.

Most State and some Federal programs provide cost-share funding for plan development and implementation. Many programs pay a fixed dollar amount per acre and others pay a percentage of costs. On a percentage basis (i.e., converting annual or annualized fixed amounts to a percentage of the estimated annual cost where necessary), the cost-share rate for this practice ranges from 28.6% to 87.5%. Thus, the estimate of the net farmer cost ranges from $0.87 to $5.00/ac/yr.

#### *2.2.1.10 Grazing Land Protection*

In the Watershed Model, grazing land protection refers to rotational grazing. Costs of the practice consist of permanent fencing around pastures and temporary or semi-permanent fencing around paddocks, labor to move water sources and animals between paddocks, and possibly increased administrative/monitoring costs. Some other operational costs, such as the cost of spreading manure over pasture land, may decline as a result of this practice.

Three sources provide costs for grazing land protection. Based on cost-share records from the Bay watershed, Camacho (1992) reports median total capital costs, including planning and technical assistance, of $119 per acre ($139 in 2001 dollars) and annual O&M costs of $5 per acre ($6 in 2001 dollars) for a suite of practices that includes grazing land protection, intensive rotational grazing systems, spring development, and trough/tank installation. Annualizing the capital cost at 5% over 10 years and adding O&M results in annual costs of $24/ac/yr. USDA-ASCS (1990 and 1991, cited in EPA, 1997a) reports costs of $10/ac/yr in the Southeast region ($13/ac/yr in 2001 dollars), and $35/ac/yr in the Northeast ($45/ac/yr in 2001 dollars), for a suite of practices including critical area planting, ponds, fencing, pipeline, spring development, stock trails and walkways, troughs/tanks, water-harvesting catchments, and wells. Shulyer (1996) reports a total cost of $2.50/ac/yr ($3 in 2001 dollars) for a "grazing land protection" BMP that includes grazing land protection systems, spring development, and stream protection; however, this estimate it is substantially lower than estimates reported from other sources and documentation is lacking. Therefore, the average cost reflects both the Northeast and Southeast regions in USDA-ASCS (1990 and 1991, cited in EPA, 1997a) and the $24/ac/yr estimate based on Camacho (1992), or $27/ac/yr. Assuming a 10-year useful life for capital components and O&M representing 5% of the initial capital cost, 72% of this cost is annualized capital and therefore eligible for cost-share.

State and Federal cost sharing for this practice ranges from 75% to 87.5% of installation costs. Thus, the net farmer cost ranges from $10 to $12/ac/yr. However, because the data sources used to derive costs for grazing land protection and the sources used to derive costs for streambank protection may include some overlapping practices, the use of these estimates may result in double-counting some costs on acres in the Watershed Model to which both BMPs are applied.

#### *2.2.1.11 Animal Waste Management Systems*

In the Watershed Model, the animal waste management system BMP refers to the construction and maintenance of facilities to handle, store, and utilize wastes generated from animal confinement operations (CBP Modeling Subcommittee, 1998). Waste management facilities may take on many forms depending on the animal species and handling method. They may include lagoons, ponds, and concrete tanks for treatment and/or storage of liquid wastes, storage sheds and pits for treatment and/or storage of solid wastes, and other structures such as concrete berms to divert waste to storage structures. The tier scenarios in the Watershed Model report animal waste management system BMP application in manure acres; one manure acre represents 145 animal units (AU), and one animal unit represents a certain number animals, depending on the species: for instance, one AU represents 0.71 dairy cows, 1 beef cow, 5 hogs, 250 layers, 500 broilers, or 100 turkeys (CBP Modeling Subcommittee, 1998).

Some of the costs for this BMP will be incurred under EPA's revised Concentrated Animal Feeding Operation (CAFO) regulations. Under these regulations, CAFOs will incur costs to implement or improve animal waste management systems, develop and implement nutrient management plans, and transfer excess manure offsite. Because the CAFO Rule is still being finalized, the extent to which the Watershed Model tiers overlap costs of the CAFO Rule is unknown. For instance, the Tier 1 requirements for animal waste systems indicate continuing the

level of implementation based on the average rate of 1997-2000 (Exhibit E-3); this level is most likely lower than would be required under the final CAFO regulations. [Note that the cost of technology-based regulations such as the anticipated CAFO rule would not be considered in analysis of substantial and widespread impact (U.S. EPA, 1995).]

Several sources contain estimates of the costs of animal waste management systems:

- MD DNR et al. (1996) reports average capital costs of $17,570 for a poultry waste system and $63,533 for other livestock system, but did not report the number of animals served by those systems and therefore the estimate cannot be converted to an average cost per manure acre

- Virginia Department of Environmental Quality (1993) reports a cost of $27,000 but does not indicate any units (e.g., whether this represents annual or one-time costs, or how many animals would be addressed)

- Tippett and Dodd (1995) reports capital costs for anaerobic lagoons of $5.60 per animal for poultry and $79 per swine and O&M costs equal to 10% of initial capital costs; however, these estimates are based on an analysis using records of State and Federal cost-share funding from 1985 to 1994, although they did not convert to constant dollars before averaging

- Shulyer (1996) reports annual costs of $8,187 per manure acre, but did not document what assumptions were used to generate the annual cost (e.g., useful life, interest rate, animal species considered)

- U.S. EPA (2001a) estimated costs for model farms of varying sizes and using a range of technologies for several animal types (e.g., beef, dairy, swine, poultry); cost breakdowns for swine and poultry do not provide sufficient resolution to permit calculation of an average cost per animal unit or manure acre, but indicate an average cost per manure acre for beef ($2,114 in 2001 dollars) and dairy ($14,243 in 2001 dollars), based on annualizing capital costs over 10 years at 5%

- Camacho (1992) reports median costs per ton of wet manure treated in an animal waste management system, based on records of State and Federal cost-share funding for farms in the Chesapeake Bay watershed and also based on costs from a manual prepared for the Pennsylvania Department of Environmental Resources; median costs per wet ton are $12.73 for capital ($14.83 in 2001 dollars), $2.16 for one-time planning and technical assistance ($2.52 in 2001 dollars), and $1.28 for O&M ($1.49 in 2001 dollars)

- Maryland Department of Agriculture (2002a) reports the average cost of installing a comprehensive animal waste management system for different size systems; the cost for systems that serve 100 or more animal units is $315 per animal unit (in the

Watershed Model, nutrient reduction efficiencies are based on systems that service 145 animal units)

However, only the last two sources listed, Camacho (1992) and Maryland Department of Agriculture (2002a), provide sufficient information to calculate an annual cost per manure acre in constant dollars using a known interest rate, and incorporate costs for poultry waste systems.

To utilize the data from Camacho (1992), the CBP calculated the sum of capital and planning/technical assistance costs (annualized at 5% over 10 years) plus O&M costs to produce an estimate of $3.27 per wet ton of manure treated. Combining this estimate with data from the 1997 Census of Agriculture on animals in the watershed counties, and standard assumptions about manure excreted for different animal species (shown in **Exhibit E-9**), produces an average cost per manure acre in the watershed. Based on the weighted average value of 12.52 tons of manure excreted per animal per year in the watershed counties, the average annual cost per manure acre is $5,932 (equal to $3.27 per wet ton manure treated times 12.52 tons wet manure per animal unit per year times 145 animal units per manure acre).

The CBP used similar assumptions to derive an annual cost based on the data from MDA (2002a). Annualizing the capital cost of $315 per animal unit at 5% over 10 years results in an annual cost of $41/animal unit/yr. Adding O&M costs equal to 10% of the initial capital cost (i.e., 10% x $315) results in an annual cost of $72/animal unit/yr, or $10,440 per manure acre per year. Averaging the estimates from Camacho (1992) and MDA (2002a) produces an annual cost of $8,186 per manure acre per year. Approximately 56% of this cost is annualized capital and therefore eligible for cost-share.

Cost sharing is provided by various programs including EQIP and several State programs. Cost share percentages range from 75% to 87.5% of installation costs. The net farmer cost, therefore, ranges from $4,175 to $4,748/manure acre/yr.

**Exhibit E-9: Derivation of Average Manure Excretion in Bay Watershed**

| Species | Animals Per Animal Unit | Wet Manure Excreted (tons/animal unit/yr) | Equivalent Wet Manure Excreted (tons/animal/yr) | Animals in Watershed Counties[1] | Animal Units in Watershed Counties |
|---|---|---|---|---|---|
| Dairy | 0.71 | 14.9 | 20.99 | 1,383,201 | 1,948,170 |
| Beef | 1 | 6.7 | 6.7 | 661,807 | 661,807 |
| Swine | 5 | 11.7 | 2.34 | 265,743 | 53,149 |
| Layers | 250 | 9.7 | 0.04 | 110,725 | 443 |
| Broilers | 500 | 13.1 | 0.03 | 1,861,093 | 3,722 |
| Turkeys | 100 | 10.2 | 0.1 | nd | nd |
| Weighted average[2] | n/a | 12.52 | n/a | n/a | n/a |

Sources: Animals per animal unit and wet manure excreted from Gilbertson, 1979, cited in Chesapeake Bay Program, 1998; animal populations from USDA-NASS, 1999. nd = No data; n/a = not applicable.
1. Number of animals in watershed counties indicates inventory of animals in 1997, except broilers, which indicates number sold in 1997.
2. Average is weighted by number of animal units by species in watershed counties in 1997.

### *2.2.1.12 Yield Reserve*

The yield reserve BMP involves applying 75% to 85% of the fertilizer recommended in a nutrient management plan (i.e., 98% to 111% of a crop's need instead of 130%). This BMP is only applied in the Tier 3 scenario. Costs consist of development and application of an NMP ($7/ac/yr, as described above). To encourage participation in a Federal pilot program, the proposed program has an incentive payment of $40/ac/yr (which may fall to $20/ac/yr to $30/ac/yr in a subsequent bid program phase) and also provides insurance against revenue losses associated with lower crop yields (personal communication with T. Simpson, University of Maryland, March 2002). In the long run, the cost of this program could equal annual revenue on the order of $20/ac/yr less than the NMP cost, or net revenue of about $13/ac/yr. However, a dedicated Yield Reserve program was not included in the 2002 Farm Bill, and although various opportunities remain to fund a program through other parts of the Bill or through other sources (personal communication with T. Simpson, University of Maryland, May 2002), the potential cost savings are not included (i.e., the estimate is $0/ac/yr instead of -$13/ac/yr).

### *2.2.1.13 Carbon Sequestration/Bio-Energy*

The carbon sequestration BMP is potentially an extension of the retirement of highly erodible land and grass buffer strip BMPs. Similar to these BMPs, the land owner plants permanent grass cover (such as switchgrass) and maintains it for 10 years or longer. This BMP differs, however, in that the land owner is allowed to harvest top growth and sell it as a biofuel for electricity generation or co-generation. If the biofuel is used in a co-fired coal plant, then it generates $CO_2$

offsets through fuel substitution. Also, continuous switchgrass ground cover is expected to sequester soil carbon in the root zone because only the top growth is harvested.

Annual harvest of switchgrass for biofuel increases the cost of this BMP. Turhollow (2000) estimates that the average "delivered" cost (i.e., including transportation) per ton of harvestable biomass is $52 (1999$). This cost incorporates costs for establishment (which includes land rent), maintenance, harvest, and transportation. Given his average yield rate of 5 tons per acre per year, the cost per acre is $260 (5 x 52). At issue is whether potential revenues for biofuel and carbon sequestration can offset this cost or at least the incremental cost of biofuel harvest and transportation.

Potential revenue sources include (1) annual sale of biomass as a fuel source for a co-fired coal and biomass generator, (2) value of $CO_2$ credits for replacing fossil fuel with biomass fuel, and (3) value of $CO_2$ credits for additional soil carbon sequestration. **Exhibit E-10** provides revenue estimates that indicate a potential for revenue from all three sources to nearly offset the $260/acre annual cost (revenues range from $229/acre to $261/acre).

**Exhibit E-10: Estimates of Potential Revenue for Carbon Sequestration BMP**

| Source | Assumptions | Revenue/Acre |
|---|---|---|
| Fuel Sales | 5 tons/acre annual average yield[1]<br>x 15 million Btu/ton (MMBtu/ton)[2]<br>x $1.05 per MMBtu[3] | $79 |
| $CO_2$ fuel-switching credits | 5 tons/acre annual average yield[1]<br>x 15 MMBtu/ton[2]<br>x 178 lbs $CO_2$/MMBtu coal[4]<br>÷ 2000 lbs per ton<br>x $20/ton $CO_2$[5] | $134 |
| $CO_2$ sequestration credits | 0.2–0.66 tons carbon/acre annual average sequestration rate[6]<br>x 44/12 conversion factor from carbon to $CO_2$<br>x $20/ton $CO_2$[5] | $16–$48[7] |
| Total | | $229–$261 |

1. Midpoint yield rate from Turhollow (2000) and Walsh and Lichtenberg (1995).
2. Heat content of switchgrass (Turhollow, 2000).
3. Projected delivered price of coal for electric generation in 2010 in 2000 dollars (EIA, 2001).
4. Projected $CO_2$ emissions rate for supercritical pulverized coal generation in 2010 (DOE, 2002). This analysis assumes net biomass emissions of zero (i.e., annual sequestration in biofuel portion of biomass offsets its annual combustion emissions). Thus, total avoided $CO_2$ emissions equals avoided coal $CO_2$ emissions.
5. Approximate upper bound of observed past trades (CO2e.com).
6. Calculated from 0.5 to 1.5 tons per hectare rate in CAST (1998).
7. This range is similar to the range of $20 to $25 per acre revenue for carbon sequestration submitted in a comment by R. Handley (Project Director, Northeast Regional Biomass/Biofuels Program, Coalition of Northeastern Governors). The cost-per-acre for planting and harvesting in this comment is $55 to $65, which is substantially less than the potential biofuel revenue alone.

This is not a contractual BMP and, therefore, there is no reason to expect a farmer to incur annual harvest and transportation costs if the fuel sales and $CO_2$ credits for fuel-switching do not offset annual costs. Therefore, the maximum cost for this BMP is the installation cost, which is $100/acre in 1999 dollars (Turhollow, 2000). Converted to 2001 dollars and annualized at 5% over 10 years, the cost is $13/ac/yr. It is conceivable, however, that the additional sources of revenue could result in a lower average cost, which would mean that the estimate exceeds the actual cost of this BMP.

#### *2.2.1.14 Manure Excess*

In the Watershed Model, this BMP represents implementation of alternative uses for excess manure from livestock operations, as opposed to spreading manure on fields. The practice may be necessary either because of declining agricultural land on which to spread the manure, or because of nutrient management plans that reduce land application. In the Watershed Model, BMP implementation requirements are expressed in units of wet tons of manure that must be exported per year.

Based on model farm cost estimates developed for the economic analysis of the proposed CAFO rule (U.S. EPA, 2001a), the estimated cost is $3.11 per wet ton per year, and represents an average across different beef and dairy farm sizes in the Mid-Atlantic States as well as transportation options and nutrient application limitations.

Cost-share funds for manure transportation off farms are available in Maryland through the Manure Transportation Program and in Delaware through the Nutrient Management Relocation Program. As of May 2002, the Maryland program was scheduled to pay 12 cents per ton-mile (or 15 cents on the Eastern Shore), plus a $1.50 per ton load rate, up to $20/ton-mile, for poultry litter. The program would also pay generally 87.5% of costs for transporting manure of other animals, subject to caps depending on moisture content and distance (personal communication with N. Astle, Maryland Manure Transportation Program, May, 2002). However, in Maryland the recipient of the manure generally pays the remaining costs of transportation, so that the net cost to the producing farmer is zero, or the farmer may even make positive returns in the process of selling the manure (personal communication with N. Astle, May, 2002).[8] The Delaware program pays 15 cents per ton-mile plus a $2.50 per ton load rate up to $20 per ton (Delaware Department of Agriculture, 2002b).

For Maryland and Delaware, the costs for hauling manure are cost-shared so the net cost to farmers is zero. In other States with no cost-share the net farmer cost is $3.11 per ton.[9]

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[8] Recent budget shortfalls in Maryland have decreased the amount provided under the cost-share program. The availability of future funding is unknown because projecting State budget outcomes is impossible; this issue can be dealt with in a sensitivity analysis.

[9] The estimated cost assumes manure is hauled an average distance of 18 miles from the producing farm, which is the average haul distance calculated by the U.S. EPA (2001a) for the CAFO Rule in the mid-Atlantic region. Longer hauling distances may be likely for farms on the Delmarva Peninsula. Net farmer costs are likely to remain zero for Delaware and Maryland farms, but the funds necessary for cost-share may increase.

### *2.2.1.15 Conservation Tillage*

In the Watershed Model, conservation tillage (CT) is defined as leaving at least 30% of the crop residue on the field between crops and reducing disturbance of the soil surface/upper horizon. Several sources of cost information indicate that CT is well-accepted by agricultural producers. For example, Tippett and Dodd (1995) note that the Federal government gives incentive payments to encourage the practice for the first three years, after which time it is hoped that farmers see net benefits and continue to use the practice on their own.

The main cost driver for this practice is the possible purchase of new equipment appropriate for the conservation tillage system. Because conservation tillage must be rotated with conventional tillage to avoid soil compaction, the practice requires the purchase or rental of equipment for both types of tillage systems (conventional and conservation). The only study that specifically states equipment costs are included is MD DNR et al. (1996), which reports a cost of $17/ac/yr (or $19 in 2001 dollars). However, it appears based on reviewing the source of that estimate (as cited in the document) that the cost actually represents incentive costs rather than equipment costs. Therefore, additional research is required to document an average annual cost per acre.

Excluding such costs may not substantially bias the analysis. Many farmers are already implementing conservation tillage and, therefore, have already purchased equipment. Indeed, many of the net conservation tillage acres in the tier scenarios are negative, indicating high implementation rates in Progress 2000. To the extent bias exists, it is primarily an underestimate of costs to cost-share programs, which provide incentive payments for implementing this practice and tax credits for purchasing equipment.

Several additional sources also use government incentive payments rather than actual equipment or practice costs. These sources (MD DNR et al., 1996; Camacho, 1992; Tippett and Dodd, 1995; and VA SNR, 2000) report incentive payments around $15 to $25/ac/yr in current dollars, or about $20-25/ac/yr in constant 2001 dollars. Camacho (1992) notes that the incentive payments do not reflect practice costs. The four studies that estimate practice costs find net costs ranging from $-2/ac/yr (i.e., a net revenue gain of $2) to $5.60/ac/yr. Some variation is a function of what crop rotation is assumed; USDA (1999) estimates that conservation tillage in corn results in a net gain, while the practice results in net costs for soy and wheat.

The average of the practice costs from USDA (1999), Smolen and Humenik (1989, cited in U.S. EPA, 1993), and Russell and Christensen (1984, cited in U.S. EPA, 1993) is $2.72/ac/yr. This cost probably excludes any additional equipment costs that might be incurred (if farmers buy new equipment sooner than necessary rather than waiting until existing equipment needs to be retired), but it also excludes incentive payments from cost-share programs. Assuming that these costs balance each other, the net farmer cost is $2.72/ac/yr. There is inadequate data regarding the prevalence of equipment purchase related to implementation to incorporate State or Federal funding applicable to the purchase of equipment for this BMP.

### 2.2.2 Forestry

In the Watershed Model, forest harvesting practices represent a suite of practices to control erosion on forest land harvested for timber. Practices may be either structural (e.g., culverts, broad-based dips, windrows) or managerial (e.g., preharvest planning, forest chemical management, fire management). Several sources provide cost estimates:

- Aust et al. (1996, cited in EPA, 2001c) estimated costs for implementation of various erosion control practices in Virginia and southeastern States, and reported costs per acre for "stringent, enforceable implementation" of $21.40/ac for the coastal plain, $38/ac for the Piedmont, and $49/ac in the mountains (1998 dollars); these costs appear to include technical assistance, quality control, and compliance

- South Carolina Forestry Commission (1993, cited in MD DNR et al. (1996), estimated costs of $12.15/mbf (1 mbf = 1,000 board feet) for loblolly/shortleaf, which is characteristic of flat sites, $14.31/mbf for oak/pine, which is characteristic of moderately sloped sites, and $14.50/mbf for oak/hickory, which is characteristic of steep sites (dollar year not reported); using data on board-feet of timber per acre in Maryland by topographic region from Frieswyk and Giovanni (1988) in MD DNR et al. (1996), this equates to $129/ac on flat sites, $152/ac on moderate sites, and $172/ac on steep sites (dollar year unknown)

- Lickwar, Hickman, and Cubbage (1992) estimated costs of $2.42/mbf or $12.56/ac on flat sites, $4.75/mbf or $24.33/ac on moderately sloped sites, and $6.08/mbf or $34.62/ac on steep sites (1987 dollars)

- Virginia Department of Environmental Quality (1993) estimated costs of $51/ac/yr (dollar year not reported) including construction, planning, technical assistance, and O&M (based on annualizing capital costs at 10% over an unspecified practice life); however, this estimate is not usable because many assumptions are not documented.

Converting estimates from Aust et al. (1996, cited in EPA, 2001c), South Carolina Forestry Commission (1993, cited in MD DNR et al., 1996), and Lickwar, Hickman, and Cubbage (1992) into 2001 dollars (using the USDA-ERS index of prices paid by farmers (USDA-ERS, 2001), and assuming the costs in the South Carolina Forestry Commission report are in 1993 dollars, results in an average cost across the three land types of $84/ac/yr. Although this average does not reflect the Virginia DEQ (1993) report due to lack of documentation, the average value of the other three sources is comparable to the DEQ estimate of $51/ac/yr (after accounting for inflation in the latter estimate) and is also conservative.

The costs from the three sources appear to reflect total costs, rather than annual costs. However, the number of acres to which the BMP is applied is expressed as a number per year, and the BMP is likely to be applied to new land every year rather than previously harvested land. If previously harvested land is re-harvested (i.e., if selective harvests are performed on the same land more

than once before 2010) and the BMP implemented previously can be re-used (e.g., a culvert that would not be damaged in the later harvest), the unit cost for this BMP will tend to be overstated.

The Forest Lands Enhancement Program, recently created by the 2002 Farm Bill, may provide public funds for landowners to implement erosion control practices during forest harvesting. However, the summaries of costs shown in Section 3 do not incorporate the potential for public cost sharing through this program.

In addition, Dissmeyer and Foster (1987, cited in EPA, 2001c) found that forest harvesting practices resulted in net cost savings in some cases in southern States due to avoiding problem soils, wet areas, and unstable slopes, and reducing erosion by revegetating cut and fill slopes. Thus, in areas where forest harvesting measures result in net cost savings, the cost estimate will overstate actual BMP costs.

### 2.2.3 Urban and Mixed Open Land

#### *2.2.3.1 Forest Buffers*

The cost to plant and maintain a forest buffer on agricultural land is also applicable to forest buffers on pervious urban and mixed open lands. One would expect that the cost estimate for the urban version of this BMP would be lower than the agricultural cost estimate because it excludes the foregone revenue of planting a buffer on cropland. However, the land rental payments under the CRP or CREP programs likely offset this net revenue impact among farmers. Consequently, the cost is $108/ac/yr for urban and agricultural buffers.

The net cost for agricultural tree buffers incorporates a cost share that ranges from 75% to 100% of installation costs. There is at least one cost-share program for urban forest buffers, the Maryland Buffer Incentive Program (BIP). This program provides private landowners with a one-time payment of $300/acre up to a maximum of $15,000 for planting and maintenance of riparian forest buffers; the program provides funding for about 300 acres ($90,000) per year (Environmental Law Institute, 2000). The estimates do not reflect this cost-share program. Palone and Todd (1998) provide some estimates of increases in lot value for lots adjacent to forest buffers, but the estimates also do not reflect offsets of this type because it is unknown whether the nonagricultural forest buffers are planted on private or public lands.

#### *2.2.3.2 Environmental Site Design*

The environmental site design (ESD) BMP, also called Low Impact Development (LID), is applied to land area under new development. The U.S. EPA (2000, p. 1) defines LID as

> a site design strategy with a goal of maintaining or replicating the pre-development hydrologic regime through the use of design techniques to create a functionally equivalent hydrologic landscape. ... LID principles are based on controlling storm water at the source by the use of micro-scale controls that are distributed throughout the site. This is unlike conventional approaches that

typically convey and manage runoff in large facilities located at the base of drainage areas.

Because this BMP is applied to newly developed acres, the cost-per-acre must incorporate the cost savings associated with avoided storm water conveyance structures (e.g., curbs, gutters, and underground pipe) as an offset to the cost of ESD measures themselves. LID practices include bioretention, grass swales, vegetated roof covers, and permeable pavements. The concept is that investing in permeable substitutes to traditional impervious surfaces avoids the cost of the surface itself, and the corresponding costs of the infrastructure required to handle its storm water runoff.

Presently, the cost information for this innovative approach to land development is anecdotal and much of the information is qualitative. The U.S. EPA (2000) states that LID practices are more cost effective compared to conventional storm water structures and also provide more aesthetic landscape features. An earlier literature review (U.S. EPA, 1996) provides some case study examples showing net cost savings of practices that can be considered LID, e.g., a $100,000 rain garden versus $400,000 for conventional storm water ponds in the Somerset project in Prince George's County, MD. The NAHB Research Center, Inc. and U.S. EPA (2001) note the following cost implications for LID measures:

- Bioretention: minimal net construction costs because higher landscaping costs could be offset by lower storm water management costs elsewhere; low maintenance costs

- Swales and grassy channels: lower costs compared to paved or impervious infrastructure (one-half to one-third the cost of curb and gutter systems), low maintenance costs, decreased requirements for downstream facilities and related infrastructure costs

- Permeable paving: higher upfront costs and maintenance, but reduced need for storm water facilities help offset the initial cost differential.

A couple of case studies cited throughout the literature provide evidence that net costs are potentially negative (i.e., the ESD costs are lower than conventional impervious surface/storm water infrastructure investments). A study cited by the NRDC (2001) and the NAHB Research Center, Inc. and U.S. EPA (2001) is the redesign of a 130-acre development project in Sherwood, Arkansas. **Exhibit E-11** provides a comparison of key development parameters between the original convention design and the revised design that preserved natural vegetation and drainage features, thereby reducing site preparation and storm water infrastructure costs. The cost comparison indicates that the latter reduced total costs by 15% and the cost per lot by 19%. The per-lot savings is higher because the revised design also increased the number of housing units.

**Exhibit E-11: Cost and Development Implications of Alternative Designs**

| Development Parameters | Conventional Development Plan | Green Development Plan |
|---|---|---|
| Lot yield | 358 | 375 |
| Street (linear ft.) | 21,770 | 21,125 |
| Collector street (linear ft.) | 7360 | 0 |
| Drainage pipe (linear ft.) | 10,098 | 6,733 |
| Total cost estimate | $4,620,600 | $3,942,100 |
| Cost per lot | $12,907 | $10,512 |
| Incremental amenities | na | 23.5 acres open space/parks |
| Incremental lot value | na | $3,000 over competitors |

Source: NAHB Research Center, Inc. and U.S. EPA (2001), citing Tyne and Associates. 2000. "Bridging the Gap: Developers Can See Green." Land Development Spring/Summer: 27-31.

Two other case studies that provide cost information include:

- a project design that included bioretention areas, rain gardens, compact weir outfalls, depressions, grass channels, wetland swales, and a specially designed storm water basin at a new 270-unit apartment complex in Aberdeen, NC, reduced storm water costs by 72% or $175,0000 compared to a traditional storm water collection system by eliminating nearly all subsurface infrastructure along with curbs and gutters (BLUE Land, Water, Infrastructure, 1999)

- developers for the Pembroke Subdivision in Frederick County, MD, were able to eliminate plans for two storm water management ponds using LID practices (thereby avoiding $200,000 in infrastructure costs), preserve a two-and-a-half acre open space and wetlands, which provided wetland mitigation savings, add two lots to the 43-acre development (adding $100,000 in value), and preserve almost 50% of the site in undisturbed wooded condition (NRDC, 2001)

Thus, the expectation is that incorporating ESD measures in new development is likely to reduce costs and the case study data for new developments indicate potential for net cost savings. Developing an average cost savings per acre, however, is not feasible given the limited data. Consequently, the net cost estimate of $0/acre reflects that any incremental ESD planning and implementation costs are completely offset through cost savings in avoided costs for conventional storm water management infrastructure that is required in most developments to handle the volume of storm water generated by creating impervious surfaces.

#### *2.2.3.3 Storm Water Retrofits*

The per-acre BMP costs for storm water retrofits distinguish between costs for pervious and impervious urban areas. In either case, there are a variety of practices that might be implemented; the choice of practice depends on a variety of site-specific conditions (e.g., site imperviousness, site size, climate, and land availability) that vary throughout the basin. Consequently, the unit costs reflects a wide variety of measures, including new construction (e.g., detention ponds, retention ponds, infiltration basins, swales, and sand filters) and retrofits to existing infrastructure (e.g., converting storm water management ponds to extended detention ponds). The costs are averages across three sources:

- Brown, W., and T. Schueler. 1997. The Economics of Storm water BMPs in the Mid-Atlantic Region. Final Report prepared by the Center for Watershed Protection (CWP) for the Chesapeake Research Consortium. As reported in related CWP documents and databases, including CWP. (no date). The Economics of Storm Water Treatment: An Update. Technical Note #90 from Watershed Protection Techniques 2(4): 395-499.

- Northern Virginia Planning District Commission (NVPDC). 1994. Urban Retrofit Techniques: Applicability, Costs, and Cost-Effectiveness. Prepared for Virginia Department of Environmental Quality.

- Livingston, E.H. 1999. "A Review of Urban Storm water Retrofitting in Florida." In *Proceedings of the Comprehensive Storm water & Aquatic Ecosystem Management Conference*, Auckland, New Zealand, February 22-26, 1999.

These studies provide cost estimates for a wide variety of BMPs designed for existing development. BMPs include actual retrofit projects as well as new construction. **Exhibit E-12** shows mean unit costs for each study distinguish between pervious and impervious area, where feasible. In most cases, the cost estimates represent the total cost to treat both water quantity and water quality volumes since the retrofits must be conservatively sized to handle the total volume of storm water runoff. The costs represent costs per acre controlled in the watershed area, not costs per project acre.

Although the average cost for impervious urban areas represents an average over a wide range of site conditions, it may be too low to represent potential costs to retrofit ultra-urban places, which are large, densely populated areas. These areas can have limited space for constructed BMPs in conjunction with high runoff volumes generated by a high percentage of impervious surface.

**Exhibit E-12: Mean Annual Storm Water Retrofit Costs (2001 dollars per acre)[1]**

| Source | Pervious Urban Area | Impervious Urban Area |
|---|---|---|
| Brown and Schueler (1997)[2] | $287 | $1,013 |
| NVPDC (1994)[3] | | |
| Retrofit structures | $289 | $289 |
| New structures | $451 | na |
| Livingston (1999)[4] | $312 | $1,164 |
| Mean across studies | $330 | $820 |

Note: Capital costs from all studies are converted to 2001 dollars using the construction cost index in the Engineering News Record. Annualized capital costs are based on the assumption that financing terms of 5% over 20 years are available to municipalities. The interest rate is higher than borrowing rates for State Revolving Fund loans, which range from 0.7% to 3.9% throughout the basin States, to reflect that possibility that some municipalities may use alternative financing arrangements such as revenue bonds or bank loans, which tend to have higher rates. Costs include either annual O&M estimates provided by the study or annual O&M costs equal to 5% of total capital costs (CWP, no date).

1. Represents total structural costs, including costs to control storm water quantity as well as quality.
2. Example costs from CWP (no date) for a 50-acre residential development and a 5-acre commercial development to demonstrate the cost function derived in Brown and Schueler.
3. Average new structure costs based on 22 projects implementing a variety of technologies including wet pond creation and sand filter installation. Average retrofit costs are based on calculated averages for sites of 5 to 300 acres for five cost functions reported in the paper. Costs for retrofitting existing flood control structures do not differ by degree of perviousness.
4. Averages for various low-density and high-density retrofit projects throughout Florida.

**Exhibit E-13** shows populations, population density, and land area for urban areas in the Basin with more than 70,000 people (based on 2000 census data for population and land area). The places with population densities of over 10 people per acre (shown in bold in the table) may experience higher costs associated with storm water controls due to the space limitations discussed above: Baltimore, MD, Washington, D.C., Arlington, VA, Alexandria, VA, and Silver Spring, MD. Five storm water retrofit projects reported in Livingston (1999) treat water from areas with impervious surface accounting for 85% or more of total surface area. The cost-per-acre estimates (in 2001 dollars) for these highly urbanized areas are:

- $682/acre to install a detention pond and sand filter for a 9.2-acre medical complex in Pinellas County
- $699/acre for a wet detention pond and treatment system for a 121-acre site in Orlando
- $1,005/acre for a berm, weir, and pump system to reuse “first flush” from an 8.1-acre site for irrigation in Winter Park

- $3,269/acre for an alum injection system and lake restoration project for a 158-acre site in Tallahassee

- 4,986/acre to install an infiltration retrofit in a 2-acre parking lot in North Redington Beach.

**Exhibit E-13: Urban Places in the Chesapeake Bay Basin with Population > 70,000 (ultra-urban places in bold)**

| Urban Place | Population (2000) | Population Density (people/acre) | Size (square miles) |
|---|---|---|---|
| **Baltimore city (MD)** | 651,154 | 12.6 | 80.8 |
| **Washington, D.C.** | 572,059 | 14.6 | 61.4 |
| Virginia Beach city (VA) | 425,257 | 2.7 | 248.3 |
| Norfolk city (VA) | 234,403 | 6.8 | 53.7 |
| Chesapeake city (VA) | 199,184 | 0.9 | 340.7 |
| Richmond city (VA) | 197,790 | 5.1 | 60.1 |
| **Arlington city (VA)** | 189,453 | 11.4 | 25.9 |
| Newport News city (VA) | 180,150 | 4.1 | 68.3 |
| Hampton city (VA) | 146,437 | 4.4 | 51.8 |
| **Alexandria city (VA)** | 128,282 | 13.2 | 15.2 |
| Portsmouth city (VA) | 100,565 | 4.7 | 33.2 |
| Columbia city (MD) | 88,254 | 5.0 | 27.6 |
| **Silver Spring city (MD)** | 76,540 | 12.7 | 9.4 |
| Scranton city (PA) | 76,415 | 4.7 | 25.2 |

These estimates produce an average cost of $1,930/acre for retrofits in ultra-urban areas. Stormwater control costs generally do not include land acquisition costs because most of the control technologies either require relatively little land area (e.g., infiltration basins) or do not require additional land purchase (e.g., retrofitting an existing detention pond to extend detention time).

Data provided by the Maryland Department of the Environment suggest that these estimates may overstate retrofit costs. A report of six case studies (MDE, 1997) indicates total capital costs that potentially range from $1,051 to $3,553 per acre; corresponding annualized costs would range from $84 to $285. A second set of 11 retrofit projects have a mean total cost of $3,529 per acre and an annualized cost of $283 per acre (S. Bieber, MD Department of Environment, personal communication, May, 2002). However, sufficient information to incorporate these data is not available.

There may be potential for cost savings through "piggybacking" storm water retrofits onto planned road or other infrastructure maintenance to reduce costs. An example provided by the

Prince Georges County (MD) Department of Environmental Resources (personal communication with L. Coffman, 8/8/02) demonstrated how the cost of a particular storm water facility, a roadway bioretention system, might be cut by 46% if the system could be installed as part of a planned road repair activity. The cost savings accrue because some of the excavation and fill work cost is incurred for road repair regardless of whether a bioretention system is added. Thus, the incremental cost of bioretention is only 54% of the cost of a typical system.

This particular example does not provide enough information to incorporate potential cost-savings into the unit cost estimate for retrofits because the original retrofit cost studies do not include bioretention systems. However, this example suggests the possibility that piggybacking opportunities may reduce costs for other storm water management technologies.

The unit cost estimates already incorporate potential cost savings opportunities to some extent because some case study costs come from retrofitting existing storm water facilities. For example, the unit cost for impervious urban land is an average of three values: $1,164/acre/yr for a set of Florida case studies with unit costs ranging from $682/acre/yr to $2,269/acre/yr; $1,013/acre/yr from a function for detention pond costs estimated by Brown and Schueler based on case studies in the Mid-Atlantic region; and a $289/acre/yr average cost for retrofit projects for existing detention ponds in the Anacostia watershed. Thus, low-cost opportunities to alter existing storm water facilities are incorporated by including the Anacostia retrofit costs in the average unit cost estimate. Although piggyback opportunities may further reduce costs for storm water retrofits, further adjustments to the cost estimates derived above are not warranted because they already incorporate the effect of cost-savings opportunities.

#### *2.2.3.4 Storm Water Management*

This control is applied to new development that occurs between 2000 and 2010.[10] Although it will incorporate many of the same structural controls as retrofits, the unit cost estimates for this measure are lower because only the water quality volume is relevant since costs associated with water quantity will be borne regardless of water quality considerations. New development in urban areas is generally required to have infrastructure to quickly remove storm water from surface areas and store it while it is gradually released. Therefore, a portion of storm water management costs in new development would be incurred regardless of water quality concerns.

**Exhibit E-14** reports costs associated with water quality volumes for the three studies included in the retrofit section as well as a fourth study that provides costs for only the water quality volume. The BMP cost estimate is based on the mean values across all the studies ($150 on pervious and $450 on impervious urban areas).

[10] The Watershed Model also includes a storm water management BMP on recent development to account for reduced loadings from development that occurred between 1986 and 2000 compared to prior development. Costs incurred prior to 2000 are not addressed here.

**Exhibit E-14: Mean Annual Storm Water Management Costs (2001 dollars per acre)[1]**

| Source | Pervious Urban Area | Impervious Urban Area |
|---|---|---|
| Brown and Schueler (1997)[2] | $96 | $338 |
| NVPDC (1994)[4] | $150 | na |
| Livingston (1999)[5] | $174 | $460 |
| U.S. EPA (1999b)[6] | $200 | $552 |
| Mean across studies | $150 | $450 |

Note: Capital costs from all studies are converted to 2001 dollars using the construction cost index in the Engineering News Record, and amortized at 5% over 25 years. Annual O&M costs estimated as 5% of total capital costs (CWP, no date).
1. Represents the share of BMP costs attributable to storm water quality requirements.
2. Example costs from CWP (no date) for a 50-acre residential development and a 5-acre commercial development to demonstrate the cost function derived in Brown and Schueler.
4. Average new structure costs based on 22 projects.
5. Average costs for low-density and high-density projects throughout Florida.
6. Averages across subsets of costs for five different structures; water quality share only (based on functions in the study).

### *2.2.3.5 Urban and Mixed Open Nutrient Management*

Urban and mixed open nutrient management involves a reduction of fertilizer applications to urban and mixed open land to reduce nutrient loadings. Although the principles and objectives of urban nutrient management are similar to its agricultural counterpart, there is one important difference–nutrient application in urban settings is not an essential input to food production. This means that although the costs associated with conducting soil samples and developing agronomically appropriate nutrient application rates are potentially transferrable to urban settings, any net revenue impact associated with yield reductions or increases is irrelevant. Furthermore, given the largely voluntary nature of urban nutrient application, it is difficult to justify a BMP unit cost assumption that would impose burdensome costs on urban households, through either direct household consumption of application services or indirect tax or fee increases to fund municipal landscape programs.

Consequently, the cost estimate is equal to the soil testing and plan development portion of the agricultural BMP cost. Only two sources are sufficiently documented to break out these costs from implementation costs; these two sources report costs of $5/ac (USDA, 1999), or $5.16/ac in 2001 dollars, and $7/ac (U.S. EPA, 2001a), or $7.22/ac in 2001 dollars, for plan development and soil testing. The mean cost is $6.19/ac; assuming the plan is good for 3 years, the annual cost is $2.06/ac/yr. This is consistent with incremental costs identified by MD DNR (E. Kanter, personal communication, 2002). Incremental application costs are unlikely because households and municipalities will minimize these types of cost impacts. State agencies and local communities might incur incremental administrative costs, but these costs are *de minimis* when

converted to a per-acre basis because the BMP applies to millions of acres. Depending on State program requirements, businesses might also have additional record keeping or paperwork requirements (e.g., recording soil sample and nutrient application rate information for each customer). States can choose, however, to implement requirements that minimize these impacts on businesses (e.g., simply requiring some additional fields in customer databases to track soil sample results and nutrient application rates).

In the Watershed Model, this BMP is applied to both pervious urban and mixed open land. For pervious urban land, the estimated cost is $2.06/ac/yr. For mixed open land (defined as herbaceous land other than agricultural land), the estimate is one quarter of this cost ($0.52/ac/yr) based on information about mixed open land from the Chesapeake Bay Program Modeling Subcommittee (CBP, 2000). This document states that mixed open land has a fertilizer application rate equal to 25% of the rate for pervious urban land. The cost of $0.52/ac/yr represents a weighted average cost between 25% of acres to which fertilizer is applied and 75% of acres where the cost of fertilizer management is zero because no fertilizer is applied (either before or after implementation of the BMP).

One option for implementing this BMP is public education and outreach to urban and suburban residents to encourage lower fertilizer application. Two analyses provide cost estimates for an outreach program: a study of a community outreach program in Kettering, MD (Coffman, 2001), and the economic analysis of the Phase II Storm Water Rule (EPA, 1999b).

The first study was conducted by the Prince George's County Department of Environmental Resources (PGDER) in the town of Kettering, (population 2,800). Kettering and the PGDER implemented the outreach program in 1993-94 as a learning tool to determine what outreach efforts were most effective. The program covered many topics (including several unrelated to nutrient management, such as car care, backyard habitat, and recycling) and used numerous educational methods, including a monthly newsletter mailed to all households, workshops, regular water quality monitoring, and storm drain system monitoring to look for illegal discharges and connections. A full-time project manager supervised the program, aided by a citizen advisory committee. The project cost about $84,000, or about $75 per household (dollar year not provided). However, pre- and post-program surveys suggested that behavioral changes were minimal. The Kettering study is not incorporated for the following reasons:

- Most of the program's pollution reduction objectives (e.g., recycling, car products, and hazardous waste) are not included in the Bay watershed nutrient reduction scenarios

- The study gave no evidence that any of the outreach tools used were cost-effective

- Some alternatives to outreach suggested by the study, such as LID, are already implemented in the watershed scenarios.

The Economic Analysis of the Final Phase II Storm Water Rule (EPA, 1999b) also included an analysis of public education and outreach costs related to reducing pollutant loadings, including

nutrients, from urban and suburban households. The National Association of Flood and Stormwater Management Agencies (NAFSMA) conducted a survey in 1998 of 1,600 jurisdictions to identify costs of existing programs for public education and outreach, illicit discharge detection and elimination, construction site storm water runoff control, post-construction storm water management in new and recent development, and pollution prevention for municipal operations. Fifty-six jurisdictions responded with usable cost and household data; the mean cost per household for all five of those activities is $9.16 per year (1998 dollars). A breakout is not provided; however, public education and outreach for nutrient control likely makes up a relatively small portion of the costs. Estimates from this source cannot be incorporated because no breakout is provided; however, the NAFSMA study appears to corroborate the idea that per-household or per-acre costs for this BMP would be relatively low.

#### *2.2.3.6 Urban Land Conversion*

In the Watershed Model, urban land conversion is a 10% to 20% reduction in planned new development acres in Tiers 2 and 3, respectively. These acres mostly represent conserved forest land and agricultural land. There are no corresponding changes in 2010 population or housing unit estimates, which implies that this BMP is achieved through a variety of approaches that do not affect overall population growth. Approaches include using infill or brownfield development in place of greenfield development, building up instead of out, and clustering greenfield development to preserve natural areas and mature trees.

Net cost estimates for any of these approaches will equal incremental development costs (e.g., additional planning/design costs, additional administrative costs/fees, and higher costs for "building up" structural materials) minus cost savings (e.g., reduced site preparation costs and reduced infrastructure costs for road and utility services) and increased property values. Thus, net BMP costs reflect net revenue impacts to developers.

Literature reviews (Redman/Johnston Associates, Ltd, 1998; U.S. EPA, 1998) provide several case studies that demonstrate infrastructure cost savings and/or increased property values that are substantial enough to offset incremental development costs. For example, the cost of providing utilities for low-density development can be almost two times higher than the cost for compact development (Pelley, 1997). Delaware case studies, cited in CWP (1998), report cost savings ranging from 39% to 63% for new cluster developments that preserved woodland areas in addition to reducing street widths and implementing vegetated BMPs.[11] Furthermore, leaving mature trees on a site can bring about premium property values (NAHB Research Center, Inc. and U.S. EPA, 2001).

Any incremental planning costs and net revenue impacts are likely completely offset by infrastructure cost savings and property value increases. Thus, there is no net revenue impact for the developer.

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[11] Reduced road widths and vegetated BMPs that promote onsite infiltration are considered part of the ESD BMP. Thus some of the cost savings in these case studies would be attributed to ESD and some to urban growth reduction.

#### *2.2.3.7 Forest Conservation*

Forest conservation, which occurs only in the 2000 Progress scenario, is patterned after the Maryland Forest Conservation Act, which seeks to preserve existing forest land that is at risk during land development and plant trees in developed areas. Until actual program costs are available, the unit cost estimate for this BMP equals the weighted average cost across two conservation scenarios. In the first scenario, a developer sets aside already forested land onsite for preservation. In the second scenario, tree planting occurs in an off-site location.

The unit cost estimate for the first scenario is the same as the urban growth reduction BMP. The cost for that BMP is $0/ac/yr, which assumes that any incremental costs associated with development plans that conserve forested acres are offset by cost savings and incremental property values.

For the second scenario, the planting and maintenance cost components reflect the forest buffer cost estimate developed for agricultural land. The cost for this BMP is $108/ac/yr. No cost-sharing is available as in the agricultural sector although lands set aside in conservation easements might qualify for tax credits.

The overall unit cost of this practice is weighted to reflect program data indicate that at least 80% of the forest conservation acres come from retained forest acres on developed sites and less than 20% of acres are planted (MD DNR, 1999). Thus, the weighted average cost is $22/ac/yr.

### 2.2.4 Onsite Wastewater Management Systems

As shown in Exhibit E-3, the denitrification BMP for onsite wastewater management systems (OSWMSs; also called onsite disposal systems, or OSDS) reduces the total nitrogen (TN) concentration of edge-of-field effluent to 10 mg/L. A variety of technologies are available to reduce nitrogen and other pollutants, but only two reduce TN sufficiently (according to the results of third-party field tests) to meet the 10 mg/L edge of field concentration. The two technologies are Amphidrome from F.R. Mahony and the MicroFAST system from BioMicrobics.

The Amphidrome process consists of a deep bed filter that alternates between aerobic and anoxic treatment, allowing for nitrification and denitrification in a single reactor. A cyclical action is created by allowing a batch of wastewater to pass from the anoxic tank through the filter into the clear well, and then reversing the flow through a pump. The cycles are repeated until the desired effluent quality is achieved. In a test by the Massachusetts Alternative Septic System Test Center (MASSTC, 2002), the Amphidrome process achieved average concentrations of 10.9 mg/L TN at the edge of the leaching trench soil absorption system (the soil absorption system is distinct from the drainage field; that is, the 10.9 mg/L TN is the concentration at the end of the technology train and more nitrogen may be removed in the drainage field). MicroFAST is a fixed film, aerated system utilizing a combination of attached and suspended growth. Microorganisms in the inner aerated media chamber digest nutrients in the wastewater. A test by the MASSTC

shows average concentrations of 12.2 mg/L TN at the edge of the leaching field soil absorption system (MASSTC, 2001a).

In Tiers 1-3, denitrification is implemented for a percentage of new systems installed between 2001 and 2010 (0% in Tier 1, 10% in Tier 2, and 100% in Tier 3), and 1% of existing systems in Tier 3 (0% in Tiers 1 and 2). The 1% in Tier 3 represents failed systems and opportunities for upgrades (i.e., systems that would be replaced regardless of the tier requirements for end-of-pipe effluent concentrations). The cost for the BMP in new homes is not addressed here because the additional expense associated with denitrification would be included in the cost of a new home and can easily be offset by cost reductions in other materials or features in the new home. Similarly, the annual O&M costs described below are relatively small and could be easily offset by selecting lower maintenance materials or features elsewhere in the home such as lower maintenance exteriors or energy-saving appliances. The development of BMP costs for existing systems is described below.

For existing systems, the BMP cost is the cost of installing denitrification technology during a system upgrade or repair. **Exhibit E-15** summarizes the costs for the two technologies. The MicroFAST treatment unit costs $3,200 (including installation, tax, and freight) for a 3-bedroom house with an average flow of 330 gpd, and electricity to operate the system would cost about $20 per month, according to a sales representative (personal communication with B. Ehrhart, Virginia DEQ, October 2002). A service contract including quarterly inspections would cost $300 per year, based on costs for Massachusetts (MASSTC, 2001a). Annualizing the $3,200 capital cost at 7.4% over 20 years results in an annualized capital cost of $312, and adding the O&M costs of $240 (electricity) and $300 (service contract) results in an annual cost of $852 per system. The Amphidrome unit costs $7,500 including installation, tax, and freight for a 3-bedroom house with an average flow of 330 gpd according to a sales representative (personal communication with B. Ehrhart, Virginia DEQ, November 2002). Electricity costs for the Amphidrome are estimated at $23 per year, based on information from the manufacturer (personal communication with P. Pedros, F.R. Mahony, November 2002). A service contract including quarterly inspections would cost about $300 per year according to the Massachusetts study (MASSTC, 2002). Annualizing the $7,500 capital cost at 7.4% over 20 years results in annualized capital costs of $730, and adding the annual O&M costs of $23 (electricity) and $300 (service contract) results in annual costs of $1,053 per system. Averaging the costs for the two technologies produces an annual average cost of $953.

**Exhibit E-15: Onsite Wastewater Management System Denitrification BMP Costs[1]**

| Component | MicroFAST Cost | Amphidrome Cost | Average Cost |
|---|---|---|---|
| Treatment unit[1] | $3,200 | $7,500 | $5,350 |
| Annualized capital cost ($/yr)[2] | $312 | $730 | $521 |
| Electricity ($/yr) | $240 | $23 | $132 |
| Service contract ($/yr) | $300 | $300 | $300 |
| Holding tank pumping ($/yr) | $67 | $67 | $67 |
| Total annual cost | $919 | $1,120 | $1,020 |

Sources: MASSTC (2001a, 2001b, 2002), NSFC (1998), Austin City Connection (2001), U.S. EPA (1999a). All costs are in 2001 dollars.
1. Includes installation, tax, and freight.
2. Annualized at 7.4% over 20 years.

This BMP also includes frequent pumping (i.e., every 3 years). The pumping costs are a mean value based on four sources: NSFC (1998), MASSTC (2001b), Austin City Connection (2001), and U.S. EPA (1999a). These sources report pumping costs that range from $124 to $268/system, with an average cost of $202/system. The cost for pumping every 3 years would be $67/system/yr (dividing the pumping cost by 3). Thus, the cost for denitrification combined with frequent pumping is $1,020/system/yr, of which $521 or 51% is annualized capital cost. This cost may exceed actual average costs for several reasons. First, it is based on a quarterly service contract, which is required by Massachusetts law for some onsite system permits but may not be required by laws in the Basin States. Second, homeowners could potentially save costs by having the unit serviced or inspected at the same time as it is pumped out. Finally, regular pumping is already required for onsite system maintenance; therefore, this cost overestimates incremental O&M costs to current onsite system owners.

In Section 3, costs for OSWMSs are reported as accruing to households. However, U.S. EPA (2002) identified several loan, cost-share, and other programs that can help homeowners pay for upgrades, including upgrades to reduce nutrient pollution:

- The Clean Water State Revolving Funds (CWSRF), which traditionally provide low- and no-interest loans for upgrades at POTWs but which can also be used for installation, repair, and upgrade of OSWMS in small-town, rural, and suburban areas; the Hardship Grant Program of the CWSRF also provides grants for improving onsite treatment in low-income regions

- The Nonpoint Source Pollution Program of the U.S. EPA OWOW provides cost-share for onsite system repairs and upgrades

- The U.S. Department of Agriculture Rural Housing Service offers direct loans, loan guarantees, and grants to low- or moderate-income individuals to finance upgrades

- State grants through the U.S. Department of Housing and Urban Development Community Block Grant Program can provide funds for improvements to OSWMSs, channeled through town or county government agencies

### 2.2.5 Summary of BMP Unit Costs

**Exhibit E-16** provides a summary of the annual unit costs for each of the agricultural, harvested forest land, urban land, and onsite system BMPs. The annual costs include annualized capital costs and annual O&M costs. The table also reports the initial capital cost per acre or system along with the assumptions used to annualize the capital cost (i.e., the annualization rate and time period).

**Exhibit E-17** provides State-level information on the agricultural BMP cost shares. It shows the variation in farmer costs by State and BMP. Farmer costs for most BMPs are lowest in Delaware, Maryland, New York, and Pennsylvania because these States have the largest cost-share percentages. Farmer costs tend to be highest in West Virginia because this State's programs have lower cost-share percentages for BMP installation costs than other Basin States. Virginia has installation cost-share percentages similar to West Virginia, but has higher incentive payments for many BMPs.

**Exhibit E-16: Summary of Unit BMP Costs**

| BMP | Land Use[1] | Total Annual Cost[2] | Capital Cost[2] | Annualization Rate | Annualization Period (years) |
|---|---|---|---|---|---|
| **Agriculture** | | | | | |
| Forest Buffers | HT, LT, H, P | $108 | $1,284 | 5% | 25 |
| Grass Buffers | HT, LT | $17 | $132 | 5% | 10 |
| Wetland Restoration | HT, LT, H, P | $116 | $1,221 | 5% | 30 |
| Retirement of Highly Erodible Land | HT, LT, H | $17 | $132 | 5% | 10 |
| Tree Planting | HT, LT, P | $108 | $1,284 | 5% | 25 |
| Farm Plans | HT, LT | $17 | $92 | 5% | 10 |
| Farm Plans | H, P | $13 | $69 | 5% | 10 |
| Cover Crops | HT, LT | $27 | na | na | na |
| Stream Protection w/Fencing | P | $104 | $578 | 5% | 10 |
| Stream Protection w/o Fencing | P | $75 | $417 | 5% | 10 |
| Nutrient Management Plan Implementation | HT, LT, H | $7 | $19 | 5% | 3 |
| Grazing Land Protection | P | $27 | $150 | 5% | 10 |

## Exhibit E-16: Summary of Unit BMP Costs

| BMP | Land Use[1] | Total Annual Cost[2] | Capital Cost[2] | Annualization Rate | Annualization Period (years) |
|---|---|---|---|---|---|
| Animal Waste Management Systems | M | $8,186 | $35,398 | 5% | 10 |
| Yield Reserve | HT, LT, H | $7 | $19 | 5% | 3 |
| Carbon Sequestration | HT, LT | $13 | $100 | 5% | 10 |
| Excess Manure Removal | M | $3.11 | na | na | na |
| Conservation Tillage | HT | $2.72 | na | na | na |
| **Forestry** | | | | | |
| Forest Harvesting Practices (Erosion Control) | F | $84 | na | na | na |
| **Urban** | | | | | |
| Forest Buffers | PU, MO | $108 | $1,284 | 5% | 25 |
| Grass Buffers | PU | $17 | $132 | 5% | 10 |
| Low-Impact Development | PU, IU | $0 | $0 | 5% | 20 |
| Storm Water Retrofits | PU | $330 | $2,550 | 5% | 20 |
| Storm Water Retrofits | IU | $820 | $6,336 | 5% | 20 |
| Storm Water Retrofits | UU | $1,930 | $14,912 | 5% | 20 |
| Storm Water Management on New Development | PU | $150 | $1,159 | 5% | 20 |
| Storm Water Management on New Development | IU | $450 | $3,477 | 5% | 20 |
| Nutrient Management | PU | $2.06 | $5.61 | 5% | 3 |
| Nutrient Management | MO | $0.52 | $1.42 | 5% | 3 |
| Urban Land Conversion | PU, IU | $0 | $0 | 5% | 25 |
| Forest Conservation | PU, IU | $22 | $257 | 5% | 25 |
| **Onsite Systems** | | | | | |
| Denitrification w/ Pumping | na | $1,020 | $5,350 | 7.4% | 20 |

na = not applicable.

1. HT = High Till; LT = Low Till; H = Hay; P = Pasture; M = Manure acres (1 manure acre = 145 animal units); PU = Pervious Urban, IU = Impervious Urban; UU = Ultra-Urban; MO = Mixed Open; F = Forest.

2. Costs are in 2001 dollars per acre, except for excess manure removal ($/wet ton) and onsite system denitrification ($/system), and reflect the cost of the practice before offsets from Federal and State cost share programs. For more information on practice costs, see written documentation.

**Exhibit E-17: Comparison of Estimated Farmer and Federal/State Program Costs for Agricultural BMPs across States (2001 $/ac/yr)[1]**

| BMP | Total Practice Cost | Farmer Cost | | | | | | Federal/State Cost-Share | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DE | MD | NY | PA | VA | WV | DE | MD | NY | PA | VA | WV |
| Forest Buffers | 108 | 23 | (8) | 23 | 11 | 28 | 34 | 85 | 116 | 85 | 97 | 80 | 74 |
| Grass Buffers | 17 | (3) | (13) | (3) | (5) | (7) | (1) | 20 | 30 | 20 | 22 | 24 | 18 |
| Wetland Restoration | 116 | 42 | 32 | 42 | 32 | 46 | 52 | 74 | 84 | 74 | 84 | 70 | 64 |
| Retirement of HEL | 17 | (3) | (13) | (3) | (5) | (7) | (1) | 20 | 30 | 20 | 22 | 24 | 18 |
| Tree Planting | 108 | 23 | 23 | 34 | 34 | 28 | 34 | 85 | 85 | 74 | 74 | 80 | 74 |
| Farm Plans (Cropland) | 17 | 7 | 7 | 7 | 5 | 8 | 8 | 10 | 10 | 10 | 12 | 9 | 9 |
| Farm Plans (Hay and Pasture Land) | 13 | 5 | 5 | 5 | 4 | 6 | 6 | 8 | 8 | 8 | 9 | 7 | 7 |
| Cover Crops | 27 | 7 | 7 | 3 | 12 | 7 | 7 | 20 | 20 | 24 | 15 | 20 | 20 |
| Stream Protection with Fencing | 104 | 48 | 38 | 38 | 29 | 48 | 48 | 56 | 66 | 66 | 75 | 56 | 56 |
| Stream Protection without Fencing | 75 | 35 | 28 | 28 | 32 | 35 | 35 | 41 | 47 | 47 | 43 | 41 | 41 |
| Nutrient Management Plan Implementation | 7 | 4 | 5 | 1 | 1 | 4 | 2 | 3 | 2 | 6 | 6 | 3 | 5 |
| Grazing Land Protection | 27 | 12 | 10 | 10 | 11 | 12 | 12 | 15 | 17 | 17 | 16 | 15 | 15 |
| Animal Waste Management Systems | 8,186 | 4,748 | 4,175 | 4,175 | 4,519 | 4,748 | 4,748 | 3,438 | 4,011 | 4,011 | 3,667 | 3,438 | 3,438 |
| Yield Reserve | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 7 | 7 | 7 | 7 | 7 |
| Carbon Sequestration | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 0 | 0 | 0 | 0 | 0 | 0 |
| Excess Manure Removal | 3.11 | 0.00 | 0.00 | 3.11 | 3.11 | 3.11 | 3.11 | 3.11 | 3.11 | 0.00 | 0.00 | 0.00 | 0.00 |
| Conservation Tillage | 2.72 | 2.72 | 2.72 | 2.72 | 2.72 | 2.72 | 2.72 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Numbers in parentheses indicate net negative costs (i.e., a cost savings).

1. Total practice costs do not include land rental costs or opportunity costs of taking land out of production. State and federal costs include installation cost share, annual maintenance, and one-time incentive payments but do not include land rental payments.

### 2.2.6 Limitations and Uncertainties in the Analysis

The estimated costs above reflect a number of assumptions that may result in under- or overestimates of actual costs. **Exhibit E-18** illustrates the sources of potential bias in the cost estimates, as well as the potential impact on costs (if known).

**Exhibit E-18: Sources of Uncertainty in the BMP Cost Estimates**

| Source | Potential Impact on Costs | Comments |
|---|---|---|
| The extent to which the tier scenarios overlap with other requirements for which costs will be incurred anyway (e.g., under the CAFO rule or CZARA) is unknown. | + | Including costs to implement the forthcoming CAFO regulations and State CZARA programs overstates the costs attributable to the tier scenarios. |
| Tax credits are not incorporated into farmer portion of agricultural BMP costs. | +[1] | Net farmer cost would be lower for producers claiming a tax credit for implementing BMPs. |
| Land rental payments assumed to offset revenue loss to farmers. | + | To the extent that rental payments exceed the net revenue loss associated with practices that involve converting land out of agricultural production, farmer costs are overestimated . |
| Annualized capital costs based on a finance or contract period rather than the useful life of equipment or material. | + | Annual costs will overstate actual costs when the equipment or material is still generating nutrient control benefits beyond the finance or contract period. |
| The average BMP unit cost estimates may have small overlaps with other BMP costs and, therefore, double-count costs. | + | Most unit BMP cost estimates correct for known practice overlaps, but there may be overlaps that are not accounted for and, therefore, costs are double-counted. For example, the unit cost estimate for streambank protection BMP includes an unknown amount of forest buffer costs, and the unit cost estimate for grazing land protection BMP includes an unknown amount of streambank protection costs. |
| Storm water retrofits do not include cost savings of "piggy back" opportunities. | + | Municipalities can realize substantial cost savings if retrofit projects can be implemented during planned maintenance, repair, or redevelopment activities. |
| All OSWMS denitrification costs apportioned to homeowners. | +[1] | Several grant and low-interest loan programs are available and would reduce the household share of the costs of OSWMS upgrades. |
| Annualized capital costs are based on assumed financing rates. | ? | Actual financing rates may differ from sector- or State-specific rates. |
| Constant unit BMP costs applied to all BMP acres in the Basin. | ? | Actual BMP costs will vary from site to site. |

+ = assumption results in overestimating costs
? = impact of assumption on cost estimates is unknown
1. Sign shown reflects an impact on direct farmer or household costs; the impact on total costs is zero since this assumption affects only the distribution of costs.

## 3.0 RESULTS

This section provides the resulting estimates of costs of the tier scenarios. The overview in Section 3.1 provides cost summaries at the watershed, State, sector, and State basin levels. The section also includes estimates of the potential distribution of total costs between the Federal, State, and local sectors, although the actual incidence may differ. Section 3.2 provides estimates at the practice level, including estimated Federal and State contributions, and total facility-level costs for point sources, without incorporating expected grant funding available for municipal facilities.

## 3.1 Overview of Estimated Costs

This section provides a summary of total annual costs and total capital costs at the watershed, State, sector, and basin levels of aggregation. Total annual costs refer to the cumulative costs for each tier scenario. Cumulative cost reflects the total cost of implementing nutrient controls in a scenario, above the cost of the Progress 2000 scenario. Total annual costs include annualized capital costs for control technologies or BMPs that require initial capital expenditures and annual O&M expenditures.

**Exhibit E-19** shows total annual cumulative costs for each of the three tier scenarios. These estimates represent the annual costs at full implementation of all controls. Therefore, actual annual costs during the period that controls are gradually phased in will be lower.

**Exhibit E-19: Total Annual Cumulative Costs (millions of 2001$)**

| Cost Category | Tier 1 (cost of current programs funded to 2010)[1] | Tier 2 (Tier 1 + Tier 2) | Tier 3 (Tier 1+ Tier 2 + Tier 3) |
|---|---|---|---|
| Total Annual Costs ($millions)[2] | $196 | $552 | $1,124 |
| Implied Cost per Household (before cost-share)[3] ($) | $31 | $88 | $178 |
| Share of Watershed Median Household Income ($49,300) | 0.1% | 0.2% | 0.4% |

1. Tier 1 costs do not include POTW NRT projects that have already been completed or funded.
2. Includes costs paid by Federal and State cost-share programs.
3. Actual household costs will vary by location and type of household (e.g., urban or farm) and will be reduced by the Federal and State funding shares. The impact analysis addresses these distributional effects.

Exhibit E-19 also shows the average annual costs for each of the projected 6.3 million households by 2010, if all costs were paid by households living in the watershed. These estimates show that the tier scenario costs are negligible compared to Bureau of Labor Statistics (2002) estimates of the average U.S. household expenditures in 2000 on eating away from home

($2,137) and entertainment ($1,863). Indeed, they are even less than average expenditures on nonalcoholic beverages ($250, excluding dairy products) and alcoholic beverages ($372). Furthermore, the cost estimates are small relative to total household expenditures of $2,489 on household utility services, which includes $877 for telephone services, $1,315 for energy services, and $296 for water and waste services.

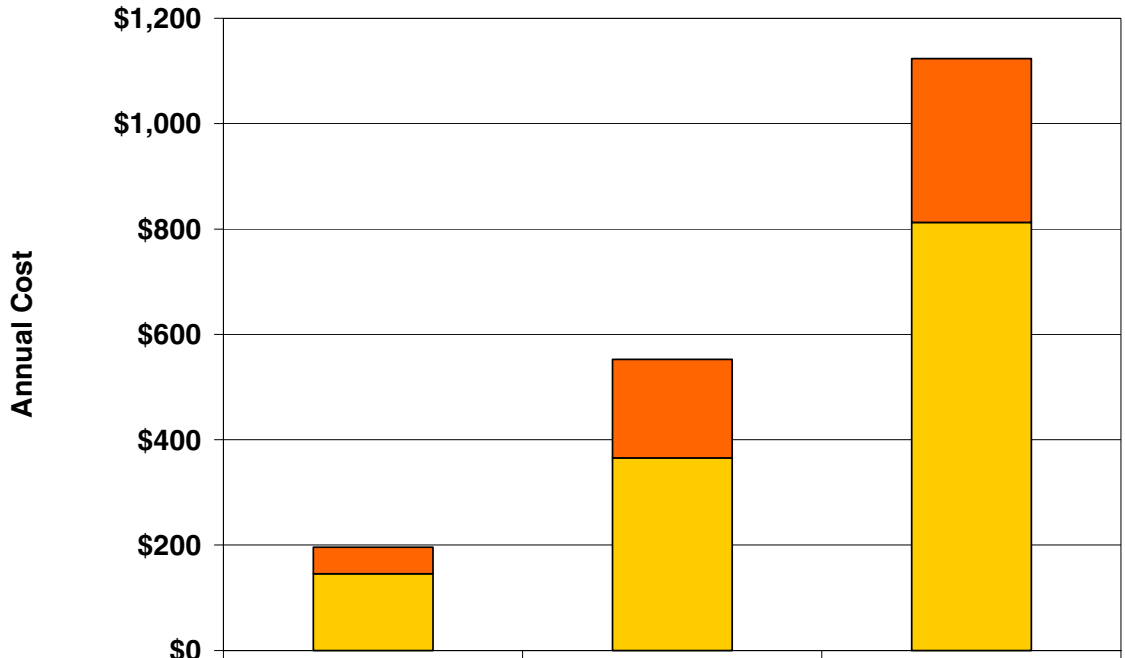
Similarly, these annual costs are small compared to median household incomes in the watershed. The median estimate for the counties in the watershed is $49,300. This estimate is in 2001 dollars and reflects incomes in the 2000 Census of Population. Average median incomes across the States range from $37,800 for the watershed counties in New York to $58,300 for Maryland.

The average cost for households in the watershed will be lower than the estimates shown in Exhibit E-19 because Federal and State cost-share programs provide financial support for nutrient controls. **Exhibit E-20** illustrates the estimated breakdown between local costs and Federal/State costs based on the cost-share assumptions described previously. Those assumptions use current cost-share information for the agricultural sector, and State estimates for the POTW sector, to project future funding. Actual cost-share amounts may differ. There are no estimates of cost shares for urban BMPs. Nevertheless, retrofit BMPs applied to developed areas may receive substantial support from Federal and State sources. Furthermore, there may be "piggy back" opportunities that reduce incremental retrofit BMP costs to a fraction of the unit costs shown above because BMPs can be cost-effectively integrated into planned infrastructure upgrades, repairs, or investments.

Federal and State programs for agricultural and POTW controls could provide $51 million of annual Tier 1 costs (or 26%), $187 million of annual Tier 2 costs (or 34%), and $311 million of annual Tier 3 costs (or 28%). The total cost-share contribution increases from Tier 1 to Tier 2 because agricultural costs increase relative to other sectors, and most costs in that sector are covered by cost-share programs. The total cost-share contribution declines from Tier 2 to Tier 3 as urban costs increasingly dominate total costs.

Total capital costs that correspond to the annual costs reported in Exhibit E-19 are $1.4 billion for Tier 1, $3.6 billion for Tier 2, and $7.6 billion for Tier 3. These estimates include anticipated Federal and State cost shares. These costs will be incurred slowly over time as controls are gradually implemented. Nevertheless, comparing them to annual economic statistics provides crucial perspective because–despite their magnitude–they are small compared to total annual personal income, which in 1999 was $574 billion ($610 billion in 2001 dollars) in the watershed counties and $1.4 trillion ($1.5 trillion in 2001 dollars) in the Basin States and the District of Columbia (BEA, 2001).

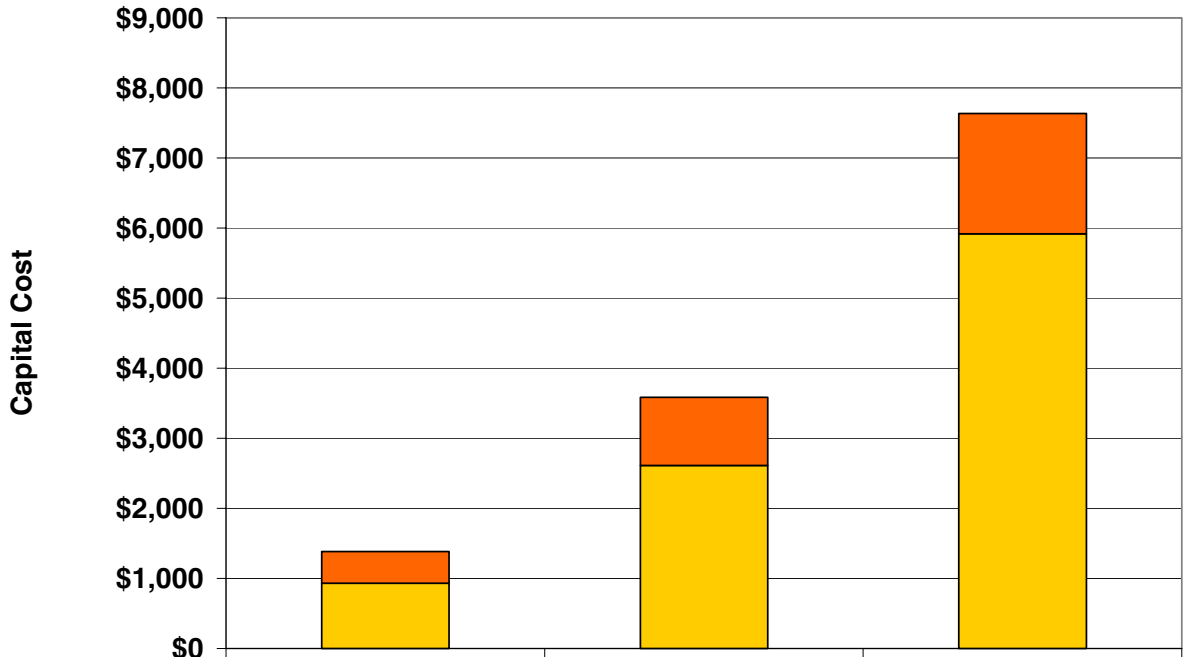
**Exhibit E-20: Estimated Distribution of Annual Costs (millions of 2001$)**




| | Tier 1 | Tier 2 | Tier 3 |
|---|---|---|---|
| State/Fed. | $51 | $187 | $311 |
| Local | $145 | $365 | $813 |

**Exhibit E-21** shows the share of capital costs estimated for Federal and State programs and the remainder estimated for private businesses and households in the watershed. These shares are based on the cost-share program funding levels described in the POTW and agricultural BMP cost sections. Actual cost-share amounts may differ. The percent of total capital costs paid through cost-share programs in Exhibit E-21 is approximately the same as the percent of total annual costs in Exhibit E-20.

**Exhibit E-21: Estimated Distribution of Capital Costs (millions of 2001$)**

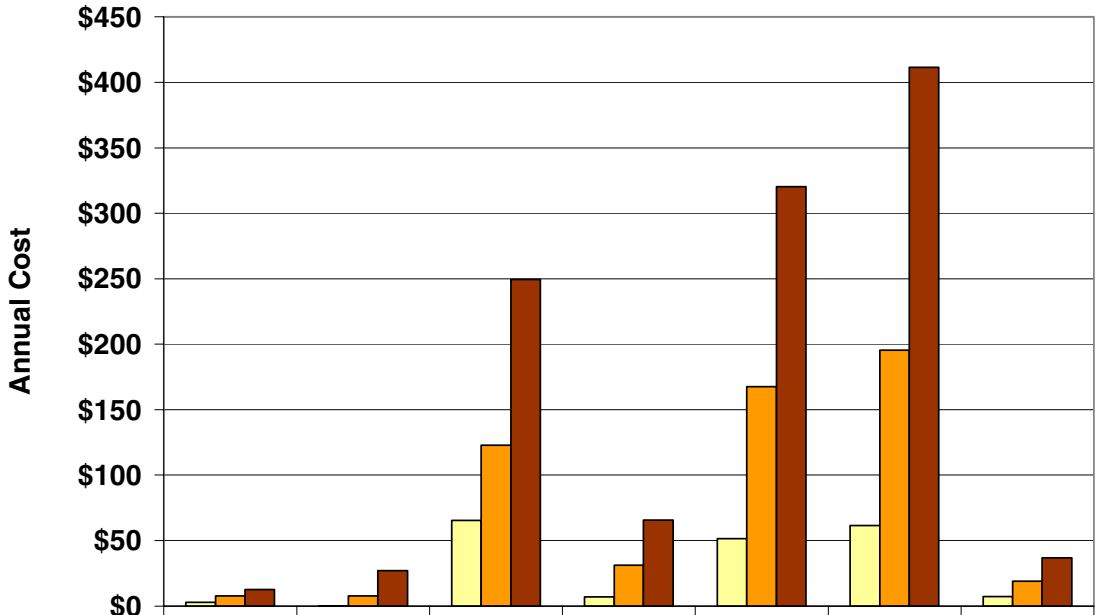



| | Tier 1 | Tier 2 | Tier 3 |
|---|---|---|---|
| State/Fed. | $451 | $976 | $1,716 |
| Local | $933 | $2,611 | $5,920 |

### 3.1.1 Cost Distribution by State

A breakdown of annual costs by State (**Exhibit E-22**) shows that three States–Maryland, Pennsylvania, and Virginia–account for almost 90% of costs across all three tier scenarios. Maryland has the largest share of annual Tier 1 costs, followed by Virginia and Pennsylvania. However, Virginia has the highest share of Tier 2 and Tier 3 costs, followed by Pennsylvania and Maryland. Maryland's shift from highest baseline (i.e., Tier 1) costs to third highest Tier 2 and Tier 3 costs signifies its high baseline implementation commitment. (Note, however, that Tier 1 costs do not completely reflect this commitment since they do not include the cost of NRT upgrades at POTWs that have already been funded or completed.)

**Exhibit E-22: Total Annual Cumulative Costs by State and Tier (millions of 2001$)**



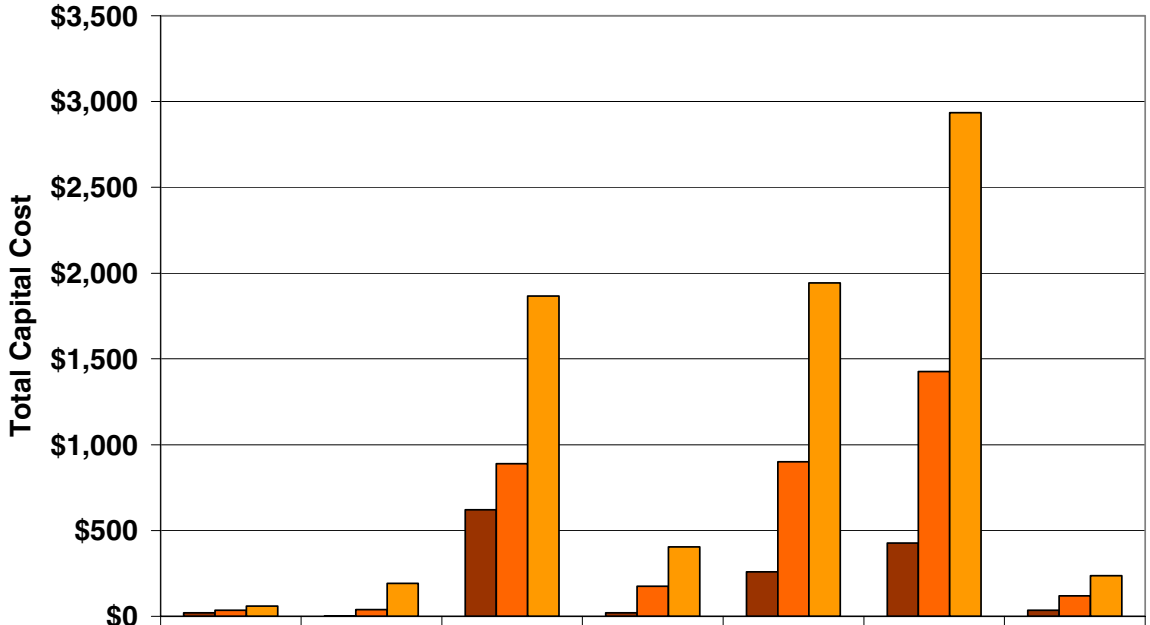

| | DE | DC | MD | NY | PA | VA | WV |
|---|---|---|---|---|---|---|---|
| Tier 1 | $3 | $0 | $65 | $7 | $51 | $61 | $7 |
| Tier 2 | $8 | $8 | $123 | $31 | $168 | $195 | $19 |
| Tier 3 | $13 | $27 | $250 | $66 | $320 | $411 | $37 |

Note: Costs for Blue Plains WWTF are apportioned to DC, MD and VA according to the method recommended by MWCOG (2002).

The cumulative cost estimates shown in Exhibit E-22 do not reflect the incremental costs of implementing controls beyond current implementation levels. The incremental costs for Tiers 2 and 3 can be derived by subtracting the Tier 1 costs from the cumulative Tier 2 and 3 costs, respectively. For example, the annual incremental cost of Tier 2 is $356 million ($552 million minus $196 million).

The distribution of capital costs across the States ( **Exhibit E-23**) follows the same pattern as annual costs in Exhibit E-22. Maryland, Pennsylvania, and Virginia account for approximately 90% of watershed costs across all tier scenarios. Maryland costs are highest in Tier 1, followed by Virginia and Pennsylvania. Tier 2 and Tier 3 capital costs in Virginia are highest, followed by Pennsylvania and Maryland. These costs include the portion that will be funded through Federal and State cost-share programs as well as costs that will be paid by businesses and households in the watershed. Similar to annual costs, they are the cumulative costs of implementing each tier scenario.

**Exhibit E-23: Total Cumulative Capital Costs by State and Tier (millions of 2001$)**



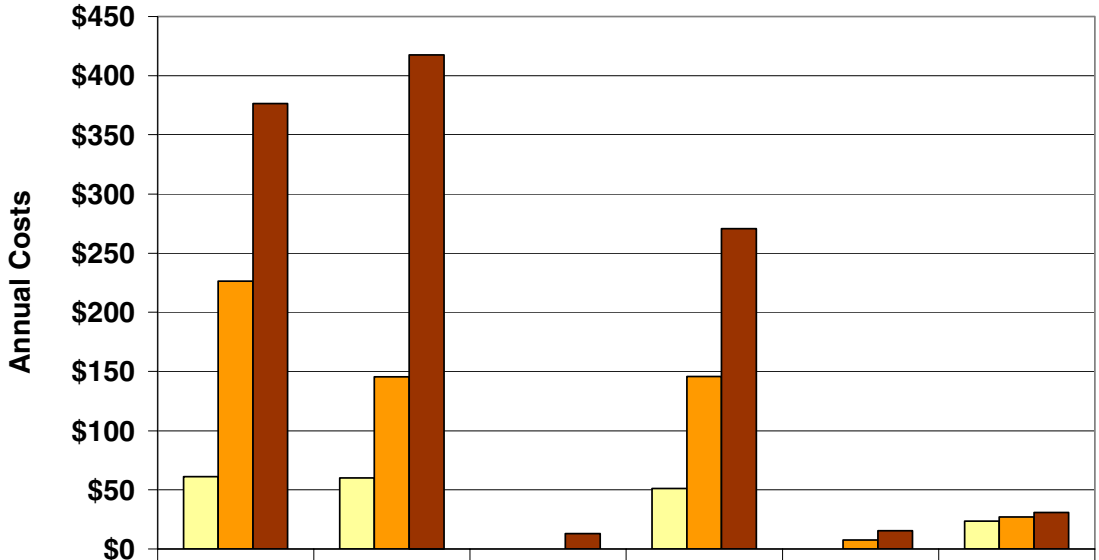

| | DE | DC | MD | NY | PA | VA | WV |
|---|---|---|---|---|---|---|---|
| Tier 1 | $21 | $3 | $621 | $20 | $258 | $426 | $35 |
| Tier 2 | $36 | $40 | $889 | $175 | $901 | $1,425 | $119 |
| Tier 3 | $60 | $192 | $1,866 | $405 | $1,944 | $2,934 | $236 |

Note: Costs for Blue Plains WWTF are apportioned to DC, MD and VA according to the method recommended by MWCOG (2002).

### 3.1.2 Cost Distribution by Sector

In **Exhibit E-24**, annual costs by sector (aggregated across States) show that the agriculture, POTW, and urban (plus mixed open) sectors account for the vast majority of costs across all tiers. The agriculture and urban sectors account for the highest share of Tier 1 costs, followed by POTW costs. In Tier 2, agricultural costs dominate total costs (41%) followed by urban costs (26%), but the urban sector has the highest cost share in Tier 3 (37%) followed by agricultural costs (33%). Growth in POTW costs is relatively steady–increasing by approximately $100 million between tier scenarios. In contrast, agricultural costs experience a larger increase between Tiers 1 and 2, while the largest increase in urban costs occurs between Tiers 2 and 3 and is attributable to the increase in implementation of storm water retrofits.

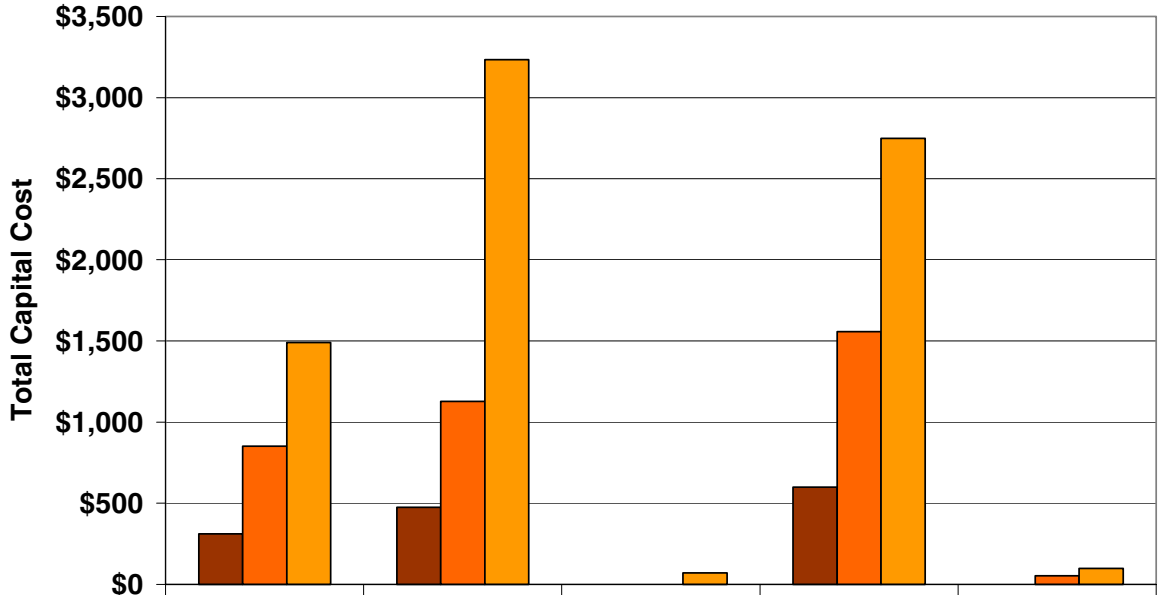
**Exhibit E-24: Total Annual Cumulative Costs by Sector and Tier (millions of 2001$)**




| | Agriculture | Urban & Mixed Open | Onsite Systems | POTW | Industrial | Forest |
|---|---|---|---|---|---|---|
| Tier 1 | $61 | $60 | $0 | $51 | $0 | $23 |
| Tier 2 | $226 | $146 | $0 | $146 | $8 | $27 |
| Tier 3 | $376 | $418 | $13 | $271 | $15 | $31 |

**Exhibit E-25** shows the breakdown of total capital costs by sector. The distribution of capital costs across sectors differs somewhat from the annual cost distribution. POTW costs account for the largest share of capital costs in Tiers 1 and 2 (43% in both instances), followed by urban and agricultural costs. In Tier 3, urban costs account for the largest share (42%) followed by POTW and agricultural costs.

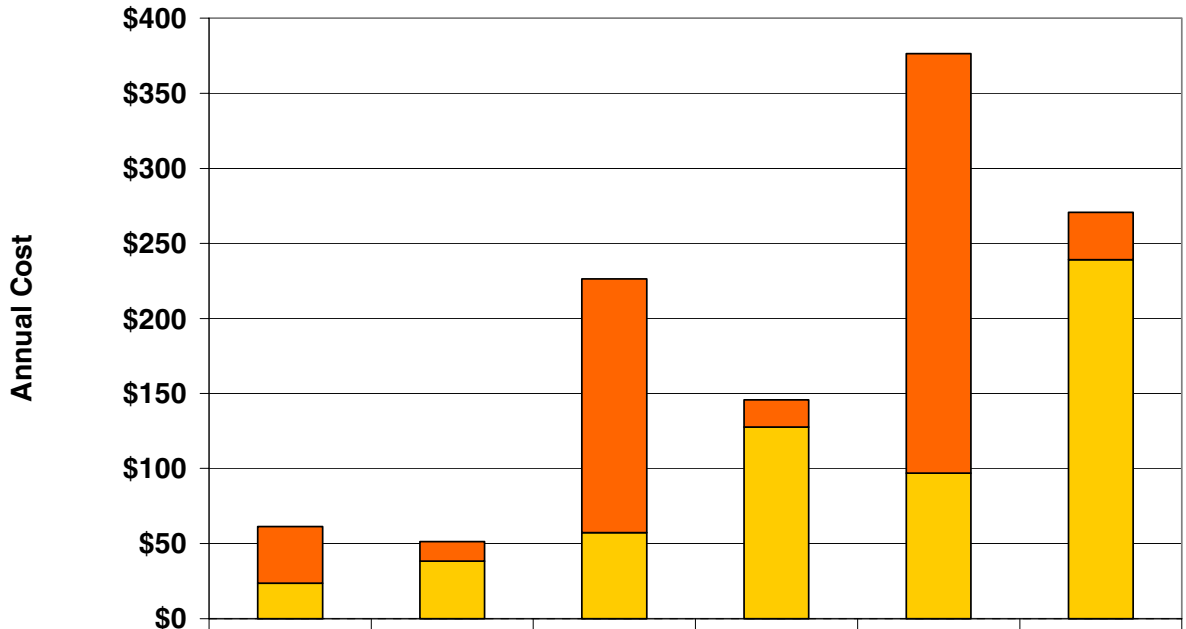
**Exhibit E-25: Total Cumulative Capital Costs by Sector and Tier (millions of 2001$)**




| | Agriculture | Urban & Mixed Open | Onsite Systems | POTW | Industrial |
|---|---|---|---|---|---|
| Tier 1 | $312 | $475 | $0 | $598 | $0 |
| Tier 2 | $850 | $1,128 | $0 | $1,557 | $51 |
| Tier 3 | $1,490 | $3,233 | $69 | $2,748 | $98 |

**Exhibit E-26** provides a comparison of estimated Federal/State and local (i.e., farmer or household) annual costs for the POTW and agricultural sectors, under the cost-share assumptions described previously. The height of each bar shows the total annual cost for each of the two sectors. Each bar also shows the estimated distribution of costs between Federal and State cost share programs and private farm businesses (in the case of agricultural costs) or local households (in the case of POTW costs). In the agricultural sector, Federal and State cost share programs contribute a majority of the total costs for each tier (61% in Tier 1, 75% in Tier 2, and 74% in Tier 3). In the POTW sector, estimated Federal and State cost sharing is lower (25% in Tier 1 and 12% in Tier 2 and 3) because cost sharing is only applied to facilities serving populations in Maryland and Virginia. The estimated Federal and State contribution is higher in Tier 1 because the largest share of annual costs for POTWs is for facilities serving populations in Maryland, and a greater proportion of costs are shared for Maryland POTWs. In Tiers 2 and 3, a larger share of POTW costs are for facilities serving populations in other States.

**Exhibit E-26: Estimated Distribution of Annual Costs for Agriculture and POTW Sectors (millions of 2001$)**




| | Tier 1 | | Tier 2 | | Tier 3 | |
|---|---|---|---|---|---|---|
| | Agriculture | POTW | Agriculture | POTW | Agriculture | POTW |
| Fed./State | $38 | $13 | $169 | $18 | $279 | $32 |
| Local | $24 | $38 | $57 | $128 | $97 | $239 |

## 3.1.3 Cost Distribution by State and Sector

This section provides the State-level cost breakdowns for each sector. Similar to earlier sections, the annual and capital cost estimates represent cumulative costs for each tier scenario and include both State and Federal cost-share amounts as well as estimated costs for private businesses and households.

### *3.1.3.1 POTW and Industrial Source Costs*

Costs for nutrient reduction technologies among POTW and industrial sources include capital expenditures and annual O&M costs. There are no industrial control costs in Tier 1. Tiers 2 and 3 include industrial controls, but POTW control costs account for more than 90% of annual costs. Total annual costs of $153 million for Tier 2 include $146 million for POTWs and $8 million for industrial facilities. Similarly, annual Tier 3 costs of $286 million include $271 million for POTWs and $15 million for industrial facilities.

**Exhibit E-27** shows the breakdown of POTW costs by State. These results show the largest share of Tier 1 costs occur in Maryland, and the largest share of Tier 2 and Tier 3 costs occur in Virginia and Pennsylvania. These results show how planned (Tier 1) NRT implementation costs vary across these states. Maryland is planning expenditures of $31.8 million annually under Tier 1, which accounts for almost 83% of cumulative costs under Tier 2 and 44% of cumulative costs under Tier 3. In contrast, Pennsylvania's Tier 1 costs are $6.5 million, which accounts for 20% of cumulative Tier 2 costs and 11% of cumulative Tier 3 costs. Virginia's Tier 1 costs are $12.7 million, which equals 21% of cumulative Tier 2 costs and 12% of Tier 3 costs.

**Exhibit E-27: Summary of Total Cumulative Annual and Capital POTW Costs[1] (millions of 2001 dollars)**

| Jurisdiction | Annual Costs | | | Capital Costs | | |
|---|---|---|---|---|---|---|
| | Tier 1 | Tier 2 | Tier 3 | Tier 1 | Tier 2 | Tier 3 |
| Delaware | $0.2 | $0.6 | $0.8 | $3.2 | $5.8 | $9.0 |
| District of Columbia | $0.0 | $5.8 | $18.8 | $0.0 | $24.3 | $127.3 |
| Maryland | $31.8 | $38.4 | $72.4 | $384.8 | $421.7 | $778.0 |
| New York | $0.0 | $6.2 | $10.2 | $0.0 | $65.2 | $105.8 |
| Pennsylvania | $6.5 | $32.0 | $60.3 | $72.1 | $354.7 | $674.5 |
| Virginia | $12.7 | $60.8 | $105.6 | $137.9 | $661.4 | $1,017.7 |
| West Virginia | $0.0 | $1.8 | $2.6 | $0.0 | $24.3 | $35.3 |
| Total | $51.2 | $145.7 | $270.7 | $597.9 | $1,557.3 | $2,747.6 |

Detail may not add to total because of independent rounding. Costs for the Blue Plains WWTF are apportioned to DC, MD, and VA according to the method recommended by MWCOG (2002).

1. Includes Federal and State cost shares equal to 10% of capital costs for VA, 50% of capital costs for MD, and 0% for remaining jurisdictions.

Total capital costs for POTWs and industrial dischargers are $0.6 billion for Tier 1, $1.6 billion for Tier 2, and $2.8 billion for Tier 3. This includes costs paid by households in the watershed as well as costs paid by Federal and State cost-share programs. Similar to annual costs, POTW accounts for more than 90% of these costs in each tier. The distribution of POTW capital costs across States, shown in Exhibit E-27, mimics the distribution of annual costs.

### *3.1.3.2 Agriculture Costs*

The total annual costs in **Exhibit E-28** include those paid by farmers and those paid by cost-share programs. Based on current implementation shares, the cost-share programs would account for approximately 75% of annual costs in Tiers 2 and 3; farmers would incur the remaining 25% of annual costs. Cost-share programs account for a smaller share of annual Tier 1 costs (60%) because BMPs with lower cost-shares such as animal waste management systems account for a larger portion of annual costs.

Annual costs are highest in Pennsylvania for all tier scenarios. Virginia has the second highest share of costs in all scenarios, followed by Maryland. Together, Pennsylvania and Virginia account for 70% of annual agricultural costs.

**Exhibit E-28: Summary of Total Cumulative Annual and Capital Agricultural Costs[1] (millions of 2001 dollars)**

| Jurisdiction | Annual Cost | | | Capital Cost | | |
|---|---|---|---|---|---|---|
| | Tier 1 | Tier 2 | Tier 3 | Tier 1 | Tier 2 | Tier 3 |
| Delaware | $2.2 | $6.3 | $9.4 | $14.4 | $22.3 | $31.6 |
| District of Columbia | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 |
| Maryland | $8.3 | $33.8 | $49.6 | $49.6 | $88.9 | $128.3 |
| New York | $1.8 | $14.7 | $28.3 | $7.5 | $61.9 | $127.5 |
| Pennsylvania | $22.2 | $90.9 | $146.6 | $110.7 | $313.5 | $527.6 |
| Virginia | $21.6 | $67.8 | $118.3 | $102.1 | $293.1 | $539.6 |
| West Virginia | $5.1 | $12.7 | $24.2 | $27.9 | $70.6 | $135.2 |
| Total | $61.3 | $226.3 | $376.3 | $312.2 | $850.4 | $1,489.9 |

Detail may not add to total because of independent rounding.
1. Based on current cost share program information, Federal and State cost-share programs would account for approximately 60% of annual costs in Tier 1 and 75% of costs in Tiers 2 and 3.

Total capital costs in the agricultural sector are $312 million for Tier 1, $850 million for Tier 2, and $1.5 billion for Tier 3. The distribution of capital costs across States (Exhibit E-28) is similar to the annual cost distribution.

### *3.1.3.3 Forestry Costs*

Annual costs to implement forest harvesting best management practices range from $23.5 million in Tier 1 to $30.8 million in Tier 3. Thus, baseline implementation in Tier 1 accounts for most of the costs in this sector. **Exhibit E-29** provides annual cost estimates by tier scenario. This sector has the smallest share of annual costs in all tier scenarios because implementation acre estimates are small. All costs are annual because practices are assumed to be implemented on different harvest acres each year.

**Exhibit E-29: Summary of Cumulative Annual Forest Harvest Costs (millions of 2001 dollars)**

| Jurisdiction | Tier 1 | Tier 2 | Tier 3 |
|---|---|---|---|
| Delaware | <$0.1 | <$0.1 | $0.1 |
| District of Columbia | $0.0 | $0.0 | $0.0 |
| Maryland | $1.6 | $1.8 | $2.0 |
| New York | $3.6 | $4.1 | $4.5 |
| Pennsylvania | $13.9 | $15.6 | $17.4 |
| Virginia | $3.0 | $4.1 | $5.1 |
| West Virginia | $1.3 | $1.5 | $1.7 |
| Total | $23.5 | $27.1 | $30.8 |

Detail may not equal total because of independent rounding.

### *3.1.3.4 Costs*

**Exhibit E-30** provides annual costs by tier and jurisdiction for urban areas. These costs are for stormwater BMPs and exclude POTW costs. Tier 1 costs are highest in Maryland and Virginia, with each accounting for 40% of annual Tier 1 costs. Maryland's share of costs declines in Tier 2 (32%) and Tier 3 (29%) while shares for other states, except Delaware, increase across the scenarios. This is indicative of Maryland's higher baseline BMP implementation rate compared to most other states. Virginia's share of total annual costs is 41% for Tiers 2 and 3. Pennsylvania's share of total annual costs increases from 15% in Tier 1 to 21% in Tier 3.

Stormwater retrofits account for over 90% of annual urban costs in all tier scenarios. Although the total number of retrofit acres is small (e.g., less than 0.4% of watershed acres in Tier 2 and 1.8% in Tier 3), the per-acre cost is high compared to other sectors. Nevertheless, the average cost per household for the 4.9 million urban households in the watershed by 2010 is expected to be small, ranging from $12 in Tier 1 to $85 in Tier 3. These estimates assume that all costs are borne by urban households. However, Federal and State cost share funds or other cost-saving opportunities might reduce these costs.

**Exhibit E-30: Summary of Cumulative Annual Urban Costs (millions of 2001 dollars)**

| Jurisdiction | Annual Cost | | | Capital Cost | | |
|---|---|---|---|---|---|---|
| | Tier 1 | Tier 2 | Tier 3 | Tier 1 | Tier 2 | Tier 3 |
| Delaware | $0.5 | $1.0 | $2.4 | $3.6 | $7.4 | $18.3 |
| District of Columbia | $0.3 | $2.1 | $8.3 | $2.6 | $16.1 | $64.4 |
| Maryland | $23.8 | $47.3 | $119.5 | $186.3 | $365.7 | $924.1 |
| New York | $1.7 | $6.4 | $21.6 | $13.0 | $48.4 | $165.8 |
| Pennsylvania | $8.8 | $27.0 | $87.7 | $75.7 | $215.1 | $684.7 |
| Virginia | $24.1 | $59.3 | $170.5 | $186.4 | $455.7 | $1,317.6 |
| West Virginia | $0.9 | $2.5 | $7.5 | $6.8 | $19.1 | $57.8 |
| Total | $60.2 | $145.5 | $417.6 | $474.5 | $1,127.6 | $3,232.7 |

Detail may not add to total because of independent rounding.

Total capital costs are $0.5 billion for Tier 1, $1.1 billion for Tier 2 and $3.2 billion for Tier 3. Exhibit E-30 shows that the distribution of capital costs across States is similar to the distribution of annual costs.

### *3.1.2.5 Onsite Waste Management System Costs*

OSWMS costs for Tiers 1 and 2 are zero, and costs are minimal for Tier 3 because only 1% of existing systems implement the control. The annual cost for Tier 3 is $13 million and total capital costs equal $68 million. Maryland, Pennsylvania, and Virginia account for most of the costs in the sector. The average annual cost per household implementing the BMP is $1,020.

The cost for new homes is not included because it will be rolled up in the overall cost of a home, and developers have an opportunity to offset incremental OSWMS costs with savings in other construction costs. Furthermore, new homes built in developments can use multi-home systems with lower average per-home costs. The cost for new homes implied by the single system annual unit cost is $8 million in Tier 2 and $82 million in Tier 3.

### *3.1.3.6 Summary*

**Exhibit E-31** summarizes the annual cost breakdowns by State and sector. The height of each bar shows the magnitude of total annual costs for each State and tier scenario. The height of sections within each bar shows the distribution of costs among the sectors for individual States and tiers. Exhibit E-31 is similar to Exhibit E-22, but it also shows the relative importance of each sector within State-level costs. For example, the POTW and urban sectors dominate costs for the District of Columbia; onsite system costs are very small in comparison (and agricultural, industrial, and forestry costs are zero). Agricultural costs tend to contribute the largest portion of costs in Delaware, Pennsylvania, and West Virginia. Conversely, POTW and urban sector costs

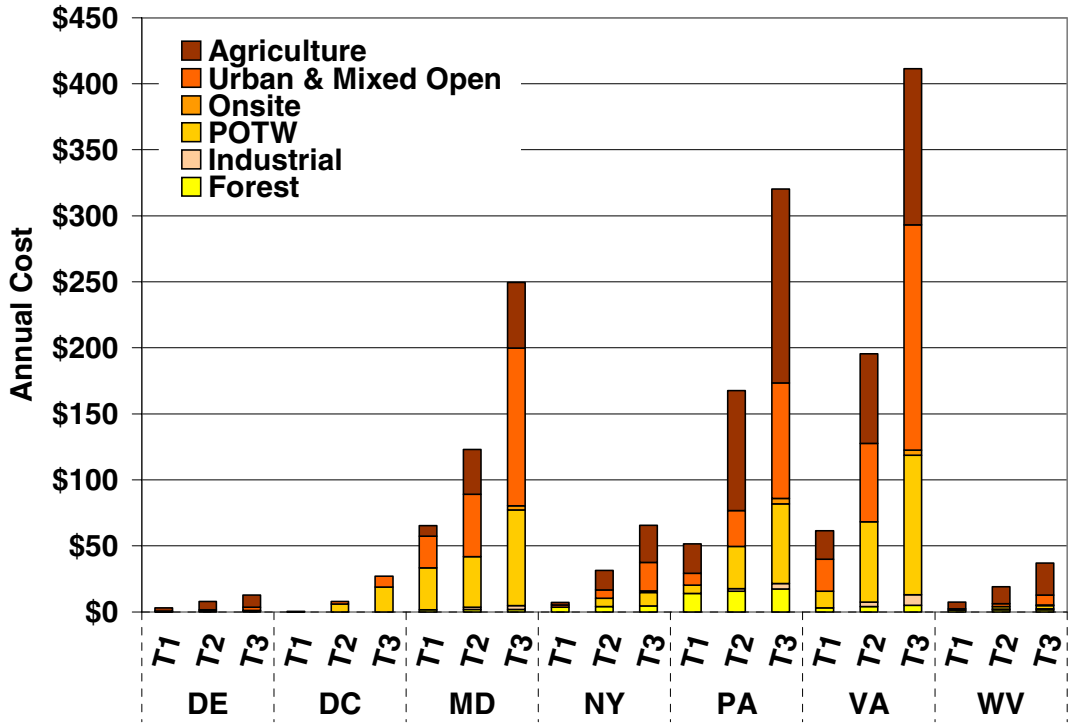
tend to dominate annual costs in Maryland and Virginia. In New York, agricultural sector costs tend to be approximately equal to the sum of POTW and urban sector costs.

Exhibit E-31 also shows the relative importance of each State within sector-level costs. For example, among all the States and the District of Columbia, Pennsylvania has the highest share of agricultural and forestry costs, while urban and POTW costs are highest in Maryland and Virginia.

Within each State, the exhibit also shows which sectors contribute most to the increase in costs across the tier scenarios. For example, in Delaware and West Virginia, growth in agricultural costs dominate increases in overall costs from Tier 1 to Tier 3. In Maryland, New York, and Pennsylvania, growth in agricultural and urban costs contribute most to cost increases across the tier scenarios. Three sectors–agriculture, urban, and POTW–contribute evenly to growth in costs for Virginia.

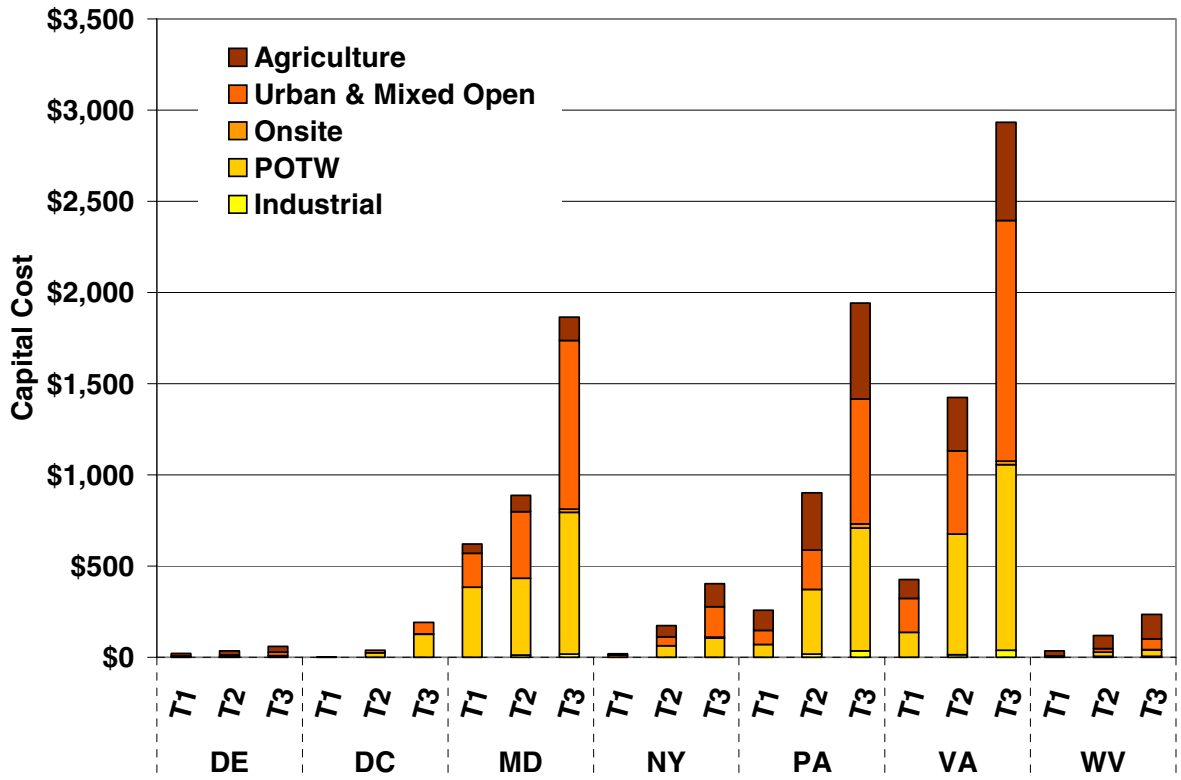
A similar summary for capital costs is in **Exhibit E-32**. The main difference between this chart and Exhibit E-31 is that the agricultural sector's share of capital costs is much smaller. Therefore, urban and POTW capital costs tend to dominate most cost distributions. Finally, the forestry sector is not included in Exhibit E-32 because there are no capital costs for that sector.

**Exhibit E-31: Total Annual Costs by State, Sector, and Tier (millions of 2001$)**




Note: Costs for the Blue Plains WWTF are apportioned to DC, MD and VA according to the method recommended by MWCOG (2002).

**Exhibit E-32: Total Capital Costs by State, Sector, and Tier (millions of 2001$)**




Note: Costs for the Blue Plains WWTF are apportioned to DC, MD, and VA according to the method recommended by MWCOG (2002).

### 3.1.4 Cost Distribution by State Basin

An annual cost summary by State basin (**Exhibits E-33** through **E-35**) provides location as well as sector detail within each State.

For Tier 1, the Susquehanna and Potomac Basins each account for nearly 30% of total annual costs, which include State and Federal cost shares as well as costs to private businesses and households. The Maryland West Shore and the James Basins each account for 13% of total annual costs and the remaining watersheds incur 8% or less of total annual costs. The agricultural and forestry sectors dominate Tier 1 costs in the Susquehanna Basin, while agricultural and urban sector costs are highest in the Potomac Basin.

In Tier 2, the Susquehanna Basin's share of total annual costs increases to 35%, and the Potomac Basin's share declines slightly to 26%. The James Basin accounts for 16% of total annual costs. Costs for the Maryland West Shore decline to 13% to 7% of total annual costs, demonstrating the effect of Maryland's relatively high Tier 1 expenditures, particularly on POTW controls. The Susquehanna Basin has 43% of total agricultural sector costs; the Potomac Basin's share is much smaller–26% of total sector costs. The Susquehanna Basin also has a higher share of POTW costs–28% of the total compared to 22% for the Potomac Basin.

The distribution of costs for Tier 3 is similar to Tier 2. The Susquehanna Basin retains the highest share—32%—with costs dominated by agricultural costs. The Potomac Basin has the second highest share of total annual costs (28%), and the James Basin the third highest share (18%). Shares for these two watersheds increase slightly because of their high urban sector costs. The Potomac Basin has 31% of urban sector costs throughout the Chesapeake Bay watershed, and the James Basin has 19%. These two watersheds also have high POTW costs—the Potomac Basin has 29% of total POTW costs and the James has 26%.

**Exhibit E-33: Annual Costs by State Basin for Tier 1 (millions of 2001 $)**

| Statebasin | Agriculture | Urban and Mixed Open | Onsite Systems | POTW | Industrial | Forest | Subtotal | Federal/ State – Agriculture[1] | Federal/ State – POTW[2] |
|---|---|---|---|---|---|---|---|---|---|
| MD-Susquehanna | 0.01 | 0.84 | 0.00 | 0.00 | 0.00 | 0.04 | 0.89 | 0.18 | 0.00 |
| NY-Susquehanna | 0.62 | 1.68 | 0.00 | 0.00 | 0.00 | 3.64 | 5.94 | 1.19 | 0.00 |
| PA-Susquehanna | 8.38 | 8.30 | 0.00 | 5.95 | 0.00 | 12.97 | 35.60 | 11.75 | 0.00 |
| Susquehanna | 9.01 | 10.82 | 0.00 | 5.95 | 0.00 | 16.64 | 42.43 | 13.12 | 0 |
| DC-Potomac | 0.00 | 0.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.33 | 0.00 | 0.00 |
| MD-Potomac | 1.55 | 9.07 | 0.00 | 3.64 | 0.00 | 0.51 | 14.77 | 3.47 | 2.30 |
| PA-Potomac | 0.73 | 0.50 | 0.00 | 0.54 | 0.00 | 0.89 | 2.66 | 1.30 | 0.00 |
| VA-Potomac | 4.83 | 9.20 | 0.00 | 2.05 | 0.00 | -0.35 | 15.73 | 4.93 | 0.17 |
| WV-Potomac | 2.38 | 0.89 | 0.00 | 0.00 | 0.00 | 1.32 | 4.58 | 2.71 | 0.00 |
| Potomac | 9.48 | 19.99 | 0.00 | 6.22 | 0.00 | 2.38 | 38.07 | 12.41 | 2.47 |
| MD-W. Shore MD | 0.01 | 6.24 | 0.00 | 11.53 | 0.00 | 0.15 | 17.93 | 0.44 | 6.97 |
| PA-W. Shore MD | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 |
| W. Shore MD | 0.02 | 6.24 | 0.00 | 11.53 | 0.00 | 0.15 | 17.94 | 0.45 | 6.97 |
| DE-E. Shore MD | 0.71 | 0.48 | 0.00 | 0.24 | 0.00 | 0.01 | 1.44 | 1.54 | 0.00 |
| MD-E. Shore MD | -0.11 | 2.47 | 0.00 | 4.62 | 0.00 | 0.79 | 7.77 | 2.77 | 2.72 |
| PA-E. Shore MD | 0.03 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.06 | 0.05 | 0.00 |
| VA-E. Shore MD | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.03 | 0.00 |
| E. Shore MD | 0.66 | 2.97 | 0.00 | 4.86 | 0.00 | 0.82 | 9.30 | 4.38 | 2.72 |
| MD-Patuxent | -0.11 | 5.18 | 0.00 | 0.00 | 0.00 | 0.10 | 5.17 | 0.05 | 0.00 |
| Patuxent | -0.11 | 5.18 | 0.00 | 0.00 | 0.00 | 0.10 | 5.17 | 0.05 | 0 |
| VA-Rappahannock | 1.04 | 1.82 | 0.00 | 1.07 | 0.00 | 0.45 | 4.38 | 1.73 | 0.09 |
| Rappahannock | 1.04 | 1.82 | 0.00 | 1.07 | 0.00 | 0.45 | 4.38 | 1.73 | 0.09 |
| VA-York | 0.83 | 1.90 | 0.00 | 1.76 | 0.00 | 1.19 | 5.67 | 1.78 | 0.17 |
| York | 0.83 | 1.90 | 0.00 | 1.76 | 0.00 | 1.19 | 5.67 | 1.78 | 0.17 |
| VA-James | 2.48 | 11.17 | 0.00 | 6.82 | 0.00 | 1.74 | 22.21 | 3.39 | 0.57 |

**Exhibit E-33: Annual Costs by State Basin for Tier 1 (millions of 2001 $)**

| Statebasin | Agriculture | Urban and Mixed Open | Onsite Systems | POTW | Industrial | Forest | Subtotal | Federal/ State – Agriculture[1] | Federal/ State – POTW[2] |
|---|---|---|---|---|---|---|---|---|---|
| WV-James | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.02 | 0.00 |
| James | 2.49 | 11.17 | 0.00 | 6.82 | 0.00 | 1.75 | 22.24 | 3.41 | 0.57 |
| VA-E. Shore VA | 0.23 | 0.05 | 0.00 | 0.00 | 0.00 | -0.01 | 0.27 | 0.29 | 0.00 |
| E. Shore VA | 0.23 | 0.05 | 0.00 | 0.00 | 0.00 | -0.01 | 0.27 | 0.29 | 0 |
| **Total** | **23.64** | **60.15** | **0.00** | **38.21** | **0.00** | **23.47** | **145.48** | **37.61** | **13** |

Detail may not add to total because of independent rounding. Costs for the Blue Plains WWTF are allocated to DC-Potomac, MD-Potomac, and VA-Potomac according to the method recommended by MWCOG (2002).

1. Includes several programs for installation and other cost-sharing.
2. POTW capital costs are shared at 50% for MD facilities, at 10% for VA facilities, and at zero for other States and the District of Columbia.

**Exhibit E-34: Annual Costs by State Basin for Tier 2 (millions of 2001 $)**

| Statebasin | Agriculture | Urban & Mixed Open | Onsite Systems | POTW | Industrial | Forest | Subtotal | Federal/ State - Agriculture[1] | Federal/ State - POTW[2] |
|---|---|---|---|---|---|---|---|---|---|
| MD-Susquehanna | 0.04 | 1.04 | 0.00 | 0.00 | 0.00 | 0.04 | 1.12 | 1.05 | 0.00 |
| NY-Susquehanna | 3.71 | 6.36 | 0.00 | 6.24 | 0.00 | 4.09 | 20.39 | 10.96 | 0.00 |
| PA-Susquehanna | 20.39 | 25.52 | 0.00 | 30.42 | 2.04 | 14.59 | 92.95 | 60.82 | 0.00 |
| Susquehanna | 24.13 | 32.91 | 0.00 | 36.65 | 2.04 | 18.73 | 114.46 | 72.84 | 0.00 |
| DC-Potomac | 0.00 | 2.10 | 0.00 | 5.81 | 0.00 | 0.00 | 7.91 | 0.00 | 0.00 |
| MD-Potomac | 1.80 | 17.70 | 0.00 | 8.33 | 0.85 | 0.57 | 29.25 | 10.87 | 3.09 |
| PA-Potomac | 2.24 | 1.44 | 0.00 | 1.60 | 0.00 | 1.00 | 6.28 | 6.87 | 0.00 |
| VA-Potomac | 9.10 | 22.82 | 0.00 | 7.55 | 1.04 | -0.22 | 40.30 | 14.85 | 0.52 |
| WV-Potomac | 5.01 | 2.50 | 0.00 | 1.83 | 0.56 | 1.48 | 11.38 | 7.64 | 0.00 |
| Potomac | 18.15 | 46.56 | 0.00 | 25.12 | 2.45 | 2.84 | 95.12 | 40.23 | 3.61 |

**Exhibit E-34: Annual Costs by State Basin for Tier 2 (millions of 2001 $)**

| Statebasin | Agriculture | Urban & Mixed Open | Onsite Systems | POTW | Industrial | Forest | Subtotal | Federal/ State - Agriculture[1] | Federal/ State - POTW[2] |
|---|---|---|---|---|---|---|---|---|---|
| MD-W. Shore MD | 0.13 | 14.68 | 0.00 | 12.02 | 0.00 | 0.17 | 27.00 | 2.66 | 7.29 |
| PA-W. Shore MD | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.07 | 0.00 |
| W. Shore MD | 0.15 | 14.68 | 0.00 | 12.02 | 0.00 | 0.17 | 27.02 | 2.73 | 7.29 |
| DE-E. Shore MD | 1.43 | 0.99 | 0.00 | 0.55 | 0.00 | 0.04 | 3.01 | 4.91 | 0.00 |
| MD-E. Shore MD | 0.08 | 4.90 | 0.00 | 4.94 | 0.00 | 0.89 | 10.81 | 16.35 | 2.77 |
| PA-E. Shore MD | 0.12 | 0.07 | 0.00 | 0.00 | 0.00 | 0.02 | 0.20 | 0.41 | 0.00 |
| VA-E. Shore MD | 0.05 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.16 | 0.00 |
| E. Shore MD | 1.67 | 5.98 | 0.00 | 5.49 | 0.00 | 0.95 | 14.08 | 21.82 | 2.77 |
| MD-Patuxent | -0.09 | 8.96 | 0.00 | 0.01 | 0.81 | 0.12 | 9.81 | 0.90 | 0.00 |
| Patuxent | -0.09 | 8.96 | 0.00 | 0.01 | 0.81 | 0.12 | 9.81 | 0.90 | 0.00 |
| VA-Rappahannock | 2.94 | 4.02 | 0.00 | 2.73 | 0.00 | 0.59 | 10.28 | 7.28 | 0.22 |
| Rappahannock | 2.94 | 4.02 | 0.00 | 2.73 | 0.00 | 0.59 | 10.28 | 7.28 | 0.22 |
| VA-York | 1.97 | 4.24 | 0.00 | 3.00 | 0.04 | 1.43 | 10.68 | 5.68 | 0.26 |
| York | 1.97 | 4.24 | 0.00 | 3.00 | 0.04 | 1.43 | 10.68 | 5.68 | 0.26 |
| VA-James | 7.98 | 27.91 | 0.00 | 42.1 | 2.18 | 2.29 | 82.45 | 15.45 | 3.77 |
| WV-James | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.05 | 0.05 | 0.00 |
| James | 8.01 | 27.91 | 0.00 | 42.1 | 2.18 | 2.30 | 82.45 | 15.5 | 3.77 |
| VA-E. Shore VA | 0.41 | 0.26 | 0.00 | 0.59 | 0.15 | -0.01 | 1.41 | 2.01 | 0.05 |
| E. Shore VA | 0.41 | 0.26 | 0.00 | 0.59 | 0.15 | -0.01 | 1.41 | 2.01 | 0.05 |
| **Total** | **57.34** | **145.52** | **0.00** | **127.72** | **7.67** | **27.11** | **365.37** | **168.98** | **17.97** |

Detail may not add to total because of independent rounding. Costs for the Blue Plains WWTF are allocated to DC-Potomac, MD-Potomac, and VA-Potomac according to the method recommended by MWCOG (2002).

1. Includes several programs for installation and other cost-sharing.

2. POTW capital costs are shared at 50% for MD facilities, at 10% for VA facilities, and at zero for other States and the District of Columbia.

**Exhibit E-35. Annual Costs by State Basin for Tier 3 (millions of 2001 $)**

| Statebasin | Agriculture | Urban & Mixed Open | Onsite Systems | POTW | Industrial | Forest | Subtotal | Federal/ State - Agriculture[1] | Federal/ State - POTW[2] |
|---|---|---|---|---|---|---|---|---|---|
| MD-Susquehanna | 0.06 | 1.34 | 0.11 | 0.07 | 0.00 | 0.05 | 1.63 | 1.61 | 0.05 |
| NY-Susquehanna | 7.96 | 21.58 | 1.13 | 10.18 | 0.00 | 4.54 | 45.4 | 20.31 | 0.00 |
| PA-Susquehanna | 32.07 | 82.91 | 3.82 | 57.99 | 4.14 | 16.22 | 197.14 | 98.56 | 0.00 |
| Susquehanna | 40.08 | 105.83 | 5.07 | 68.24 | 4.14 | 20.81 | 244.17 | 120.48 | 0.05 |
| DC-Potomac | 0.00 | 8.35 | 0.03 | 18.78 | 0.00 | 0.00 | 27.16 | 0.00 | 0.00 |
| MD-Potomac | 1.94 | 44.23 | 1.02 | 20.48 | 1.79 | 0.64 | 70.09 | 15.58 | 8.17 |
| PA-Potomac | 3.89 | 4.49 | 0.24 | 2.28 | 0.00 | 1.12 | 12.02 | 11.08 | 0.00 |
| VA-Potomac | 13.61 | 66.52 | 1.27 | 23.71 | 1.24 | -0.09 | 106.26 | 25.89 | 1.70 |
| WV-Potomac | 9.80 | 7.50 | 0.38 | 2.62 | 0.61 | 1.65 | 22.55 | 14.21 | 0.00 |
| Potomac | 29.24 | 131.09 | 2.94 | 67.86 | 3.64 | 3.31 | 238.09 | 66.76 | 9.87 |
| MD-W. Shore MD | 0.20 | 41.93 | 1.06 | 19.66 | 0.05 | 0.19 | 63.08 | 4.11 | 11.59 |
| PA-W. Shore MD | 0.03 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 | 0.10 | 0.00 |
| W. Shore MD | 0.23 | 41.95 | 1.06 | 19.66 | 0.05 | 0.19 | 63.13 | 4.22 | 11.59 |
| DE-E. Shore MD | 2.09 | 2.39 | 0.18 | 0.79 | 0.00 | 0.07 | 5.52 | 7.31 | 0.00 |
| MD-E. Shore MD | 0.15 | 12.14 | 0.61 | 6.34 | 0.00 | 0.99 | 20.23 | 24.58 | 3.56 |
| PA-E. Shore MD | 0.19 | 0.27 | 0.04 | 0.00 | 0.00 | 0.02 | 0.52 | 0.66 | 0.00 |
| VA-E. Shore MD | 0.06 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 | 0.23 | 0.00 |
| E. Shore MD | 2.49 | 14.85 | 0.83 | 7.13 | 0.00 | 1.08 | 26.37 | 32.78 | 3.56 |
| MD-Patuxent | -0.07 | 19.91 | 0.44 | 1.63 | 0.87 | 0.13 | 22.9 | 1.45 | 0.89 |
| Patuxent | -0.07 | 19.91 | 0.44 | 1.63 | 0.87 | 0.13 | 22.9 | 1.45 | 0.89 |
| VA-Rappahannock | 5.27 | 10.79 | 0.44 | 4.95 | 0.00 | 0.72 | 22.17 | 12.51 | 0.41 |
| Rappahannock | 5.27 | 10.79 | 0.44 | 4.95 | 0.00 | 0.72 | 22.17 | 12.51 | 0.41 |
| VA-York | 3.19 | 11.48 | 0.58 | 4.27 | 0.14 | 1.67 | 21.33 | 9.26 | 0.35 |
| York | 3.19 | 11.48 | 0.58 | 4.27 | 0.14 | 1.67 | 21.33 | 9.26 | 0.35 |
| VA-James | 15.86 | 80.69 | 1.6 | 64.57 | 6.30 | 2.84 | 171.86 | 28.85 | 4.90 |
| WV-James | 0.07 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.09 | 0.10 | 0.00 |
| James | 15.93 | 80.71 | 1.6 | 64.57 | 6.30 | 2.85 | 171.96 | 28.94 | 4.90 |

**Exhibit E-35. Annual Costs by State Basin for Tier 3 (millions of 2001 $)**

| Statebasin | Agriculture | Urban & Mixed Open | Onsite Systems | POTW | Industrial | Forest | Subtotal | Federal/ State - Agriculture[1] | Federal/ State - POTW[2] |
|---|---|---|---|---|---|---|---|---|---|
| VA-E. Shore VA | 0.54 | 0.96 | 0.06 | 0.68 | 0.25 | 0.00 | 2.49 | 2.97 | 0.06 |
| E. Shore VA | 0.54 | 0.96 | 0.06 | 0.68 | 0.25 | 0.00 | 2.49 | 2.97 | 0.06 |
| **Total** | **96.91** | **417.57** | **13.03** | **238.99** | **15.37** | **30.75** | **812.62** | **279.37** | **31.68** |

Detail may not add to total because of independent rounding. Costs for the Blue Plains WWTF are allocated to DC-Potomac, MD-Potomac, and VA-Potomac according to the method recommended by MWCOG (2002).

1. Includes several programs for installation and other cost-sharing.
2. POTW capital costs are shared at 50% for MD facilities, at 10% for VA facilities, and at zero for other States and the District of Columbia.

## 3.2 Detailed Cost Estimates

**Exhibit E-36** shows the BMP costs for each State for Tiers 1–3, calculated by multiplying the acres shown in Exhibit E-4 and the unit costs shown in Exhibit E-16 (note that the acres shown in Exhibit E-4 are rounded). Negative total costs indicate a reduction in BMP acres compared to the Progress 2000 Scenario because of a change from agriculture to another land use. Negative farmer costs indicate a cost savings (i.e., that estimated State and Federal contributions exceed the cost of the BMP). Capital cost-sharing does not exceed 100% of capital costs, since none of the identified cost-share programs permit this, but the sum of upfront capital cost-share, incentive payments, *and* annual maintenance payments exceeds the annual cost of the BMP when farmer costs are negative.

The Blue Plains facility treats wastewater from Maryland, Virginia, and the District of Columbia. Thus, in Exhibit E-36, NRT costs for the Blue Plains WWTF are allocated to each of the jurisdictions according to their corresponding percentage of flow treated by Blue Plains (see MWCOG, 2002).

**Exhibit E-37** summarizes the capital, O&M, and total annual (i.e., annualized capital plus annual O&M) costs for each significant municipal and industrial facility in the watershed. Since Exhibit E-37 shows facility-level costs, the costs for the Blue Plains WWTF are not distinguished by the jurisdictions it serves. The costs in the exhibit represent the total cumulative cost of achieving each tier, including cost-share funds that offset the cost of NRT at municipal facilities.

Note that Exhibit E-37 includes several State-owned and Federal facilities. Households in the watershed will not incur direct costs for these facilities and, therefore, efforts are being made to identify all of these facilities and exclude them from future analyses.

## Exhibit E-36: Estimated Costs of Tier 1: Delaware (2001$)

| Urban | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Forest Buffers | 234 | 2,797 | 35 |
| Grass Buffers | 9,605 | 74,167 | 0 |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | 0 |
| Storm Water Retrofits | 79,964 | 617,844 | 30,386 |
| Storm Water Management on New Dev. | 361,963 | 2,796,733 | 137,546 |
| Nutrient Management | 31,612 | 86,086 | 0 |
| Urban Land Conversion | 0 | 0 | 0 |
| Forest Conservation | 0 | 0 | 0 |
| Total | 483,377 | 3,577,627 | 167,967 |

| Agriculture | Total Annual[1] | Capital | Annual O&M | Annual Land Rental[2] | Farmer Share of Annual Cost[3] | Federal/State Share of Annual Cost |
|---|---|---|---|---|---|---|
| Forest Buffers | 650,607 | 3,304,451 | 41,375 | 374,773 | 57,912 | 592,695 |
| Grass Buffers | 127,076 | 141,013 | 0 | 108,814 | -3,088 | 130,164 |
| Wetland Restoration | 39,577 | 234,091 | 7,166 | 17,183 | 8,104 | 31,472 |
| Retirement of Highly Erodible Land | 0 | 0 | 0 | 0 | 0 | 0 |
| Tree Planting | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Plans | 0 | 0 | 0 | 0 | 0 | 0 |
| Cover Crops | 0 | 0 | 0 | 0 | 0 | 0 |
| Stream Protection w/ Fencing | 0 | 0 | 0 | 0 | 0 | 0 |
| Stream Protection w/o Fencing | 0 | 0 | 0 | 0 | 0 | 0 |
| Nutrient Management Plan Implementation[4] | 1,167,989 | 10,602,410 | 0 | 0 | 622,371 | 545,618 |
| Grazing Land Protection | 0 | 0 | 0 | 0 | 0 | 0 |
| Animal Waste Management Systems | 31,905 | 137,963 | 14,038 | 0 | 18,505 | 13,400 |
| Yield Reserve[4] | 0 | 0 | 0 | 0 | 0 | 0 |
| Carbon Sequestration | 0 | 0 | 0 | 0 | 0 | 0 |
| Excess Manure Removal | 221,702 | 0 | 221,702 | 0 | 0 | 221,702 |
| Conservation Tillage | 1,962 | 0 | 1,962 | 0 | 1,962 | 0 |
| Total | 2,240,817 | 14,419,927 | 286,243 | 500,770 | 705,766 | 1,535,051 |

| Forest | Total Annual |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 14,685 |

| Onsite Wastewater Management Systems | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Denitrification w/ Pumping | 0 | 0 | 0 |

| Point Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Municipal | 239,875 | 3,187,400 | 63,244 |
| Industrial | 0 | 0 | 0 |
| Total | 239,875 | 3,187,400 | 63,244 |

| All Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Total | 2,978,754 | 21,184,954 | 517,454 |

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

## Exhibit E-36: Estimated Costs of Tier 1: District of Columbia (2001$)

| Urban | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Forest Buffers | 60 | 714 | 9 |
| Grass Buffers | 2,451 | 18,924 | 0 |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | 0 |
| Storm Water Retrofits | 331,687 | 2,562,806 | 126,041 |
| Storm Water Management on New Dev. | 0 | 0 | 0 |
| Nutrient Management | 0 | 0 | 0 |
| Urban Land Conversion | 0 | 0 | 0 |
| Forest Conservation | 0 | 0 | 0 |
| Total | 334,198 | 2,582,444 | 126,050 |

| Agriculture | Total Annual[1] | Capital | Annual O&M | Annual Land Rental[2] | Farmer Share of Annual Cost[3] | Federal/State Share of Annual Cost |
|---|---|---|---|---|---|---|
| Forest Buffers | 0 | 0 | 0 | 0 | 0 | 0 |
| Grass Buffers | 0 | 0 | 0 | 0 | 0 | 0 |
| Wetland Restoration | 0 | 0 | 0 | 0 | 0 | 0 |
| Retirement of Highly Erodible Land | 0 | 0 | 0 | 0 | 0 | 0 |
| Tree Planting | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Plans | 0 | 0 | 0 | 0 | 0 | 0 |
| Cover Crops | 0 | 0 | 0 | 0 | 0 | 0 |
| Stream Protection w/ Fencing | 0 | 0 | 0 | 0 | 0 | 0 |
| Stream Protection w/o Fencing | 0 | 0 | 0 | 0 | 0 | 0 |
| Nutrient Management Plan Implementation[4] | 0 | 0 | 0 | 0 | 0 | 0 |
| Grazing Land Protection | 0 | 0 | 0 | 0 | 0 | 0 |
| Animal Waste Management Systems | 0 | 0 | 0 | 0 | 0 | 0 |
| Yield Reserve[4] | 0 | 0 | 0 | 0 | 0 | 0 |
| Carbon Sequestration | 0 | 0 | 0 | 0 | 0 | 0 |
| Excess Manure Removal | 0 | 0 | 0 | 0 | 0 | 0 |
| Conservation Tillage | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 0 | 0 | 0 | 0 | 0 | 0 |

| Forest | Total Annual |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 0 |

| Onsite Wastewater Management Systems | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Denitrification w/ Pumping | 0 | 0 | 0 |

| Point Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Municipal[5] | 0 | 0 | 0 |
| Industrial | 0 | 0 | 0 |
| Total | 0 | 0 | 0 |

| All Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Total | 334,198 | 2,582,444 | 126,050 |

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.
5. Costs for Blue Plains WWTF are allocated to Maryland, Virginia, and the District of Columbia as recommended by MWCOG (2002).

# Exhibit E-36: Estimated Costs of Tier 1: Maryland (2001$)

| Urban | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Forest Buffers | 572,384 | 6,857,076 | 85,858 |
| Grass Buffers | 340,710 | 2,630,870 | 0 |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | 0 |
| Storm Water Retrofits | 4,195,385 | 32,415,941 | 1,594,246 |
| Storm Water Management on New Dev. | 18,691,867 | 144,424,027 | 7,102,909 |
| Nutrient Management | 0 | 0 | 0 |
| Urban Land Conversion | 0 | 0 | 0 |
| Forest Conservation | 0 | 0 | 0 |
| Total | 23,800,346 | 186,327,914 | 8,783,014 |

| Agriculture | Total Annual[1] | Capital | Annual O&M | Annual Land Rental[2] | Farmer Share of Annual Cost[3] | Federal/State Share of Annual Cost |
|---|---|---|---|---|---|---|
| Forest Buffers | 3,891,132 | 23,075,131 | 288,924 | 1,964,971 | -140,342 | 4,031,475 |
| Grass Buffers | 1,024,591 | 1,011,164 | 0 | 893,640 | -99,176 | 1,123,766 |
| Wetland Restoration | 0 | 0 | 0 | 0 | 0 | 0 |
| Retirement of Highly Erodible Land | 157,261 | 180,675 | 0 | 133,863 | -17,721 | 174,982 |
| Tree Planting | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Plans | 830,139 | 4,481,575 | 249,755 | 0 | 322,303 | 507,836 |
| Cover Crops | -862,958 | 0 | -862,958 | 0 | -223,730 | -639,228 |
| Stream Protection w/ Fencing | 1,504,720 | 8,365,718 | 421,322 | 0 | 556,747 | 947,974 |
| Stream Protection w/o Fencing | 222,346 | 1,236,169 | 62,257 | 0 | 82,268 | 140,078 |
| Nutrient Management Plan Implementation[4] | 872,566 | 7,920,713 | 0 | 0 | 623,261 | 249,305 |
| Grazing Land Protection | 0 | 0 | 0 | 0 | 0 | 0 |
| Animal Waste Management Systems | 772,924 | 3,342,256 | 340,087 | 0 | 394,191 | 378,733 |
| Yield Reserve[4] | 0 | 0 | 0 | 0 | 0 | 0 |
| Carbon Sequestration | 0 | 0 | 0 | 0 | 0 | 0 |
| Excess Manure Removal | -13,153 | 0 | -13,153 | 0 | 0 | -13,153 |
| Conservation Tillage | -145,758 | 0 | -145,758 | 0 | -145,758 | 0 |
| Total | 8,253,812 | 49,613,399 | 340,476 | 2,992,474 | 1,352,044 | 6,901,768 |

| Forest | Total Annual |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 1,592,527 |

| Onsite Wastewater Management Systems | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Denitrification w/ Pumping | 0 | 0 | 0 |

| Point Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Municipal[5] | 31,775,121 | 384,749,909 | 7,788,496 |
| Industrial | 0 | 0 | 0 |
| Total | 31,775,121 | 384,749,909 | 7,788,496 |

| All Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Total | 65,421,806 | 620,691,222 | 16,911,985 |

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.
5. Costs for Blue Plains WWTF are allocated to Maryland, Virginia, and the District of Columbia as recommended by MWCOG (2002).

## Exhibit E-36: Estimated Costs of Tier 1: New York (2001$)

| Urban | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Forest Buffers | 1,965 | 23,545 | 295 |
| Grass Buffers | 80,840 | 624,228 | 0 |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | 0 |
| Storm Water Retrofits | 806,622 | 6,232,423 | 306,516 |
| Storm Water Management on New Dev. | 792,426 | 6,122,733 | 301,122 |
| Nutrient Management | 0 | 0 | 0 |
| Urban Land Conversion | 0 | 0 | 0 |
| Forest Conservation | 0 | 0 | 0 |
| Total | 1,681,854 | 13,002,928 | 607,933 |

| Agriculture | Total Annual[1] | Capital | Annual O&M | Annual Land Rental[2] | Farmer Share of Annual Cost[3] | Federal/State Share of Annual Cost |
|---|---|---|---|---|---|---|
| Forest Buffers | 0 | 0 | 0 | 0 | 0 | 0 |
| Grass Buffers | 0 | 0 | 0 | 0 | 0 | 0 |
| Wetland Restoration | 0 | 0 | 0 | 0 | 0 | 0 |
| Retirement of Highly Erodible Land | 433,622 | 789,762 | 0 | 331,345 | -17,297 | 450,919 |
| Tree Planting | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Plans | 0 | 0 | 0 | 0 | 0 | 0 |
| Cover Crops | 0 | 0 | 0 | 0 | 0 | 0 |
| Stream Protection w/ Fencing | 0 | 0 | 0 | 0 | 0 | 0 |
| Stream Protection w/o Fencing | 0 | 0 | 0 | 0 | 0 | 0 |
| Nutrient Management Plan Implementation[4] | 126,281 | 1,146,315 | 0 | 0 | 15,785 | 110,496 |
| Grazing Land Protection | 209,254 | 1,163,380 | 58,591 | 0 | 77,424 | 131,830 |
| Animal Waste Management Systems | 1,011,757 | 4,375,012 | 445,173 | 0 | 515,996 | 495,761 |
| Yield Reserve[4] | 0 | 0 | 0 | 0 | 0 | 0 |
| Carbon Sequestration | 0 | 0 | 0 | 0 | 0 | 0 |
| Excess Manure Removal | 0 | 0 | 0 | 0 | 0 | 0 |
| Conservation Tillage | 29,853 | 0 | 29,853 | 0 | 29,853 | 0 |
| Total | 1,810,767 | 7,474,468 | 533,617 | 331,345 | 621,761 | 1,189,006 |

| Forest | Total Annual |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 3,635,376 |

| Onsite Wastewater Management Systems | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Denitrification w/ Pumping | 0 | 0 | 0 |

| Point Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Municipal | 0 | 0 | 0 |
| Industrial | 0 | 0 | 0 |
| Total | 0 | 0 | 0 |

| All Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Total | 7,127,997 | 20,477,397 | 1,141,550 |

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

## Exhibit E-36: Estimated Costs of Tier 1: Pennsylvania (2001$)

| Urban | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Forest Buffers | 1,787,376 | 21,412,504 | 268,106 |
| Grass Buffers | 393,284 | 3,036,834 | 0 |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | 0 |
| Storm Water Retrofits | 3,227,571 | 24,938,052 | 1,226,477 |
| Storm Water Management on New Dev. | 3,409,722 | 26,345,454 | 1,295,694 |
| Nutrient Management | 0 | 0 | 0 |
| Urban Land Conversion | 0 | 0 | 0 |
| Forest Conservation | 0 | 0 | 0 |
| Total | 8,817,952 | 75,732,844 | 2,790,277 |

| Agriculture | Total Annual[1] | Capital | Annual O&M | Annual Land Rental[2] | Farmer Share of Annual Cost[3] | Federal/State Share of Annual Cost |
|---|---|---|---|---|---|---|
| Forest Buffers | 223,036 | 1,312,681 | 16,436 | 113,462 | 11,363 | 211,673 |
| Grass Buffers | 37,194 | 34,236 | 0 | 32,760 | -1,304 | 38,498 |
| Wetland Restoration | 81,106 | 489,136 | 14,974 | 34,313 | 12,957 | 68,149 |
| Retirement of Highly Erodible Land | 537,128 | 687,003 | 0 | 448,158 | -26,168 | 563,295 |
| Tree Planting | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Plans | 7,988,447 | 43,146,864 | 2,400,731 | 0 | 2,400,731 | 5,587,716 |
| Cover Crops | 0 | 0 | 0 | 0 | 0 | 0 |
| Stream Protection w/ Fencing | 713,633 | 3,967,546 | 199,817 | 0 | 199,817 | 513,815 |
| Stream Protection w/o Fencing | 55,927 | 310,933 | 15,659 | 0 | 23,713 | 32,214 |
| Nutrient Management Plan Implementation[4] | 1,434,155 | 13,018,531 | 0 | 0 | 286,831 | 1,147,324 |
| Grazing Land Protection | 86,218 | 479,342 | 24,141 | 0 | 36,556 | 49,662 |
| Animal Waste Management Systems | 10,923,744 | 47,236,144 | 4,806,447 | 0 | 6,029,907 | 4,893,837 |
| Yield Reserve[4] | 0 | 0 | 0 | 0 | 0 | 0 |
| Carbon Sequestration | 0 | 0 | 0 | 0 | 0 | 0 |
| Excess Manure Removal | 9,617 | 0 | 9,617 | 0 | 9,617 | 0 |
| Conservation Tillage | 158,920 | 0 | 158,920 | 0 | 158,920 | 0 |
| Total | 22,249,124 | 110,682,417 | 7,646,743 | 628,693 | 9,142,941 | 13,106,184 |

| Forest | Total Annual |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 13,880,287 |

| Onsite Wastewater Management Systems | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Denitrification w/ Pumping | 0 | 0 | 0 |

| Point Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Municipal | 6,490,146 | 72,079,813 | 1,866,433 |
| Industrial | 0 | 0 | 0 |
| Total | 6,490,146 | 72,079,813 | 1,866,433 |

| All Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Total | 51,437,510 | 258,495,073 | 12,303,453 |

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

# Exhibit E-36: Estimated Costs of Tier 1: Virginia (2001$)

| Urban | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Forest Buffers | 18,367 | 220,036 | 2,755 |
| Grass Buffers | 755,486 | 5,833,663 | 0 |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | 0 |
| Storm Water Retrofits | 6,158,798 | 47,586,385 | 2,340,343 |
| Storm Water Management on New Dev. | 17,170,631 | 132,670,093 | 6,524,840 |
| Nutrient Management | 45,366 | 123,542 | 0 |
| Urban Land Conversion | 0 | 0 | 0 |
| Forest Conservation | 0 | 0 | 0 |
| Total | 24,148,648 | 186,433,719 | 8,867,938 |

| Agriculture | Total Annual[1] | Capital | Annual O&M | Annual Land Rental[2] | Farmer Share of Annual Cost[3] | Federal/State Share of Annual Cost |
|---|---|---|---|---|---|---|
| Forest Buffers | 847,877 | 5,349,858 | 66,986 | 401,306 | 115,364 | 732,513 |
| Grass Buffers | 162,030 | 181,989 | 0 | 138,462 | -9,705 | 171,735 |
| Wetland Restoration | 201,687 | 1,214,791 | 37,188 | 85,476 | 45,673 | 156,014 |
| Retirement of Highly Erodible Land | 3,383,002 | 4,119,205 | 0 | 2,849,546 | -219,658 | 3,602,660 |
| Tree Planting | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Plans | 9,073,602 | 48,538,411 | 2,787,656 | 0 | 4,359,143 | 4,714,460 |
| Cover Crops | -946,558 | 0 | -946,558 | 0 | -236,639 | -709,918 |
| Stream Protection w/ Fencing | 1,057,642 | 5,880,117 | 296,140 | 0 | 486,515 | 571,127 |
| Stream Protection w/o Fencing | 0 | 0 | 0 | 0 | 0 | 0 |
| Nutrient Management Plan Implementation[4] | 1,467,264 | 13,319,083 | 0 | 0 | 838,437 | 628,828 |
| Grazing Land Protection | 2,881,677 | 16,021,111 | 806,869 | 0 | 1,325,571 | 1,556,105 |
| Animal Waste Management Systems | 1,730,494 | 7,482,955 | 761,418 | 0 | 1,003,687 | 726,808 |
| Yield Reserve[4] | 0 | 0 | 0 | 0 | 0 | 0 |
| Carbon Sequestration | 0 | 0 | 0 | 0 | 0 | 0 |
| Excess Manure Removal | 1,827,469 | 0 | 1,827,469 | 0 | 1,827,469 | 0 |
| Conservation Tillage | -105,986 | 0 | -105,986 | 0 | -105,986 | 0 |
| Total | 21,580,201 | 102,107,520 | 5,531,181 | 3,474,789 | 9,429,871 | 12,150,330 |

| Forest | Total Annual |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 3,019,242 |

| Onsite Wastewater Management Systems | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Denitrification w/ Pumping | 0 | 0 | 0 |

| Point Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Municipal[5] | 12,707,027 | 137,897,837 | 2,649,908 |
| Industrial | 0 | 0 | 0 |
| Total | 12,707,027 | 137,897,837 | 2,649,908 |

| All Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Total | 61,455,118 | 426,439,077 | 17,049,027 |

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.
5. Costs for Blue Plains WWTF are allocated to Maryland, Virginia, and the District of Columbia as recommended by MWCOG (2002).

## Exhibit E-36: Estimated Costs of Tier 1: West Virginia (2001$)

| Urban | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Forest Buffers | 802 | 9,612 | 120 |
| Grass Buffers | 33,004 | 254,845 | 0 |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | 0 |
| Storm Water Retrofits | 270,464 | 2,089,761 | 102,776 |
| Storm Water Management on New Dev. | 581,455 | 4,492,653 | 220,953 |
| Nutrient Management | 0 | 0 | 0 |
| Urban Land Conversion | 0 | 0 | 0 |
| Forest Conservation | 0 | 0 | 0 |
| Total | 885,725 | 6,846,872 | 323,850 |

| Agriculture | Total Annual[1] | Capital | Annual O&M | Annual Land Rental[2] | Farmer Share of Annual Cost[3] | Federal/State Share of Annual Cost |
|---|---|---|---|---|---|---|
| Forest Buffers | 39,340 | 321,293 | 4,023 | 12,520 | 8,480 | 30,859 |
| Grass Buffers | 25,004 | 48,685 | 0 | 18,699 | -278 | 25,282 |
| Wetland Restoration | 0 | 0 | 0 | 0 | 0 | 0 |
| Retirement of Highly Erodible Land | 21,921 | 48,760 | 0 | 15,606 | -279 | 22,200 |
| Tree Planting | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Plans | 3,041,942 | 16,227,374 | 940,423 | 0 | 1,465,803 | 1,576,139 |
| Cover Crops | -9,421 | 0 | -9,421 | 0 | -2,355 | -7,065 |
| Stream Protection w/ Fencing | 62,432 | 347,103 | 17,481 | 0 | 28,719 | 33,714 |
| Stream Protection w/o Fencing | 275 | 1,531 | 77 | 0 | 127 | 149 |
| Nutrient Management Plan Implementation[4] | 113,956 | 1,034,433 | 0 | 0 | 28,489 | 85,467 |
| Grazing Land Protection | 1,544,232 | 8,585,385 | 432,385 | 0 | 710,346 | 833,885 |
| Animal Waste Management Systems | 303,591 | 1,312,778 | 133,580 | 0 | 176,083 | 127,508 |
| Yield Reserve[4] | 0 | 0 | 0 | 0 | 0 | 0 |
| Carbon Sequestration | 0 | 0 | 0 | 0 | 0 | 0 |
| Excess Manure Removal | 0 | 0 | 0 | 0 | 0 | 0 |
| Conservation Tillage | -25,815 | 0 | -25,815 | 0 | -25,815 | 0 |
| Total | 5,117,457 | 27,927,343 | 1,492,733 | 46,825 | 2,389,320 | 2,728,137 |

| Forest | Total Annual |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 1,328,544 |

| Onsite Wastewater Management Systems | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Denitrification w/ Pumping | 0 | 0 | 0 |

| Point Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Municipal | 0 | 0 | 0 |
| Industrial | 0 | 0 | 0 |
| Total | 0 | 0 | 0 |

| All Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Total | 7,331,726 | 34,774,215 | 1,816,583 |

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

## Exhibit E-36: Estimated Costs of Tier 2: Delaware (2001$)

| Urban | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Forest Buffers | 12,439 | 149,013 | 1,866 |
| Grass Buffers | 8,644 | 66,749 | 0 |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | 0 |
| Storm Water Retrofits | 499,772 | 3,861,523 | 189,913 |
| Storm Water Management on New Dev. | 411,322 | 3,178,105 | 156,302 |
| Nutrient Management | 54,452 | 148,286 | 0 |
| Urban Land Conversion | 0 | 0 | 0 |
| Forest Conservation | 0 | 0 | 0 |
| Total | 986,628 | 7,403,677 | 348,081 |

| Agriculture | Total Annual[1] | Capital | Annual O&M | Annual Land Rental[2] | Farmer Share of Annual Cost[3] | Federal/State Share of Annual Cost |
|---|---|---|---|---|---|---|
| Forest Buffers | 1,083,343 | 5,522,386 | 69,146 | 622,370 | 96,783 | 986,560 |
| Grass Buffers | 254,741 | 275,772 | 0 | 219,028 | -6,040 | 260,781 |
| Wetland Restoration | 39,577 | 234,091 | 7,166 | 17,183 | 8,104 | 31,472 |
| Retirement of Highly Erodible Land | 1,059,660 | 1,676,070 | 0 | 842,601 | -36,708 | 1,096,368 |
| Tree Planting | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Plans | 829,226 | 4,479,396 | 249,124 | 0 | 321,637 | 507,590 |
| Cover Crops | 1,679,761 | 0 | 1,679,761 | 0 | 419,940 | 1,259,821 |
| Stream Protection w/ Fencing | 17,447 | 97,000 | 4,885 | 0 | 8,026 | 9,421 |
| Stream Protection w/o Fencing | 7,130 | 39,639 | 1,996 | 0 | 3,280 | 3,850 |
| Nutrient Management Plan Implementation[4] | 1,061,261 | 9,633,587 | 0 | 0 | 565,500 | 495,760 |
| Grazing Land Protection | 30,401 | 169,019 | 8,512 | 0 | 13,984 | 16,417 |
| Animal Waste Management Systems | 37,044 | 160,183 | 16,299 | 0 | 21,485 | 15,558 |
| Yield Reserve[4] | 0 | 0 | 0 | 0 | 0 | 0 |
| Carbon Sequestration | 0 | 0 | 0 | 0 | 0 | 0 |
| Excess Manure Removal | 221,972 | 0 | 221,972 | 0 | 0 | 221,972 |
| Conservation Tillage | 13,249 | 0 | 13,249 | 0 | 13,249 | 0 |
| Total | 6,334,812 | 22,287,143 | 2,272,111 | 1,701,181 | 1,429,241 | 4,905,571 |

| Forest | Total Annual |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 44,020 |

| Onsite Wastewater Management Systems | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Denitrification w/ Pumping | 0 | 0 | 0 |

| Point Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Municipal | 552,811 | 5,815,797 | 230,527 |
| Industrial | 0 | 0 | 0 |
| Total | 552,811 | 5,815,797 | 230,527 |

| All Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Total | 7,918,271 | 35,506,616 | 2,850,719 |

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

## Exhibit E-36: Estimated Costs of Tier 2: District of Columbia (2001$)

| Urban | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Forest Buffers | 3,174 | 38,021 | 476 |
| Grass Buffers | 2,206 | 17,031 | 0 |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | 0 |
| Storm Water Retrofits | 2,076,376 | 16,043,269 | 789,023 |
| Storm Water Management on New Dev. | 0 | 0 | 0 |
| Nutrient Management | 14,385 | 39,173 | 0 |
| Urban Land Conversion | 0 | 0 | 0 |
| Forest Conservation | 0 | 0 | 0 |
| Total | 2,096,140 | 16,137,494 | 789,499 |

| Agriculture | Total Annual[1] | Capital | Annual O&M | Annual Land Rental[2] | Farmer Share of Annual Cost[3] | Federal/State Share of Annual Cost |
|---|---|---|---|---|---|---|
| Forest Buffers | 0 | 0 | 0 | 0 | 0 | 0 |
| Grass Buffers | 0 | 0 | 0 | 0 | 0 | 0 |
| Wetland Restoration | 0 | 0 | 0 | 0 | 0 | 0 |
| Retirement of Highly Erodible Land | 0 | 0 | 0 | 0 | 0 | 0 |
| Tree Planting | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Plans | 0 | 0 | 0 | 0 | 0 | 0 |
| Cover Crops | 0 | 0 | 0 | 0 | 0 | 0 |
| Stream Protection w/ Fencing | 0 | 0 | 0 | 0 | 0 | 0 |
| Stream Protection w/o Fencing | 0 | 0 | 0 | 0 | 0 | 0 |
| Nutrient Management Plan Implementation[4] | 0 | 0 | 0 | 0 | 0 | 0 |
| Grazing Land Protection | 0 | 0 | 0 | 0 | 0 | 0 |
| Animal Waste Management Systems | 0 | 0 | 0 | 0 | 0 | 0 |
| Yield Reserve[4] | 0 | 0 | 0 | 0 | 0 | 0 |
| Carbon Sequestration | 0 | 0 | 0 | 0 | 0 | 0 |
| Excess Manure Removal | 0 | 0 | 0 | 0 | 0 | 0 |
| Conservation Tillage | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 0 | 0 | 0 | 0 | 0 | 0 |

| Forest | Total Annual |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 0 |

| Onsite Wastewater Management Systems | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Denitrification w/ Pumping | 0 | 0 | 0 |

| Point Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Municipal[5] | 5,809,313 | 24,263,400 | 4,267,550 |
| Industrial | 0 | 0 | 0 |
| Total | 5,809,313 | 24,263,400 | 4,267,550 |

| All Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Total | 7,905,454 | 40,400,894 | 5,057,049 |

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.
5. Costs for Blue Plains WWTF are allocated to Maryland, Virginia, and the District of Columbia as recommended by MWCOG (2002).

# Exhibit E-36: Estimated Costs of Tier 2: Maryland (2001$)

| Urban | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Forest Buffers | 1,039,840 | 12,457,130 | 155,976 |
| Grass Buffers | 303,006 | 2,339,734 | 0 |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | 0 |
| Storm Water Retrofits | 26,216,002 | 202,559,788 | 9,962,081 |
| Storm Water Management on New Dev. | 18,922,461 | 146,205,730 | 7,190,535 |
| Nutrient Management | 800,481 | 2,179,909 | 0 |
| Urban Land Conversion | 0 | 0 | 0 |
| Forest Conservation | 0 | 0 | 0 |
| Total | 47,281,791 | 365,742,292 | 17,308,592 |

| Agriculture | Total Annual[1] | Capital | Annual O&M | Annual Land Rental[2] | Farmer Share of Annual Cost[3] | Federal/State Share of Annual Cost |
|---|---|---|---|---|---|---|
| Forest Buffers | 8,805,605 | 52,510,649 | 657,487 | 4,422,358 | -319,368 | 9,124,973 |
| Grass Buffers | 2,412,068 | 2,589,720 | 0 | 2,076,687 | -254,001 | 2,666,069 |
| Wetland Restoration | 961,043 | 6,002,266 | 183,744 | 386,843 | 158,301 | 802,742 |
| Retirement of Highly Erodible Land | 9,858,895 | 11,539,825 | 0 | 8,364,435 | -1,131,834 | 10,990,729 |
| Tree Planting | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Plans | -984,682 | -5,313,725 | -296,530 | 0 | -382,549 | -602,133 |
| Cover Crops | 8,699,357 | 0 | 8,699,357 | 0 | 2,255,389 | 6,443,968 |
| Stream Protection w/ Fencing | 1,739,112 | 9,668,850 | 486,951 | 0 | 643,471 | 1,095,640 |
| Stream Protection w/o Fencing | 227,298 | 1,263,699 | 63,644 | 0 | 84,100 | 143,198 |
| Nutrient Management Plan Implementation[4] | 43,723 | 396,894 | 0 | 0 | 31,231 | 12,492 |
| Grazing Land Protection | 1,213,802 | 6,748,311 | 339,864 | 0 | 449,107 | 764,695 |
| Animal Waste Management Systems | 810,839 | 3,506,205 | 356,769 | 0 | 413,528 | 397,311 |
| Yield Reserve[4] | 0 | 0 | 0 | 0 | 0 | 0 |
| Carbon Sequestration | 0 | 0 | 0 | 0 | 0 | 0 |
| Excess Manure Removal | -14,655 | 0 | -14,655 | 0 | 0 | -14,655 |
| Conservation Tillage | 9,974 | 0 | 9,974 | 0 | 9,974 | 0 |
| Total | 33,782,377 | 88,912,693 | 10,486,604 | 15,250,323 | 1,957,348 | 31,825,029 |

| Forest | Total Annual |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 1,791,593 |

| Onsite Wastewater Management Systems | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Denitrification w/ Pumping | 0 | 0 | 0 |

| Point Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Municipal[5] | 38,444,013 | 421,664,283 | 12,156,020 |
| Industrial | 1,657,260 | 12,462,345 | 591,809 |
| Total | 40,101,273 | 434,126,628 | 12,747,829 |

| All Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Total | 122,957,035 | 888,781,614 | 40,543,026 |

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.
5. Costs for Blue Plains WWTF are allocated to Maryland, Virginia, and the District of Columbia as recommended by MWCOG (2002).

# Exhibit E-36: Estimated Costs of Tier 2: New York (2001$)

| Urban | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Forest Buffers | 104,690 | 1,254,168 | 15,703 |
| Grass Buffers | 72,755 | 561,792 | 0 |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | 0 |
| Storm Water Retrofits | 5,041,389 | 38,952,644 | 1,915,728 |
| Storm Water Management on New Dev. | 900,484 | 6,957,651 | 342,184 |
| Nutrient Management | 235,687 | 641,833 | 0 |
| Urban Land Conversion | 0 | 0 | 0 |
| Forest Conservation | 0 | 0 | 0 |
| Total | 6,355,003 | 48,368,088 | 2,273,615 |

| Agriculture | Total Annual[1] | Capital | Annual O&M | Annual Land Rental[2] | Farmer Share of Annual Cost[3] | Federal/State Share of Annual Cost |
|---|---|---|---|---|---|---|
| Forest Buffers | 1,584,359 | 12,404,134 | 155,312 | 548,943 | 217,389 | 1,366,969 |
| Grass Buffers | 237,642 | 408,479 | 0 | 184,742 | -8,946 | 246,588 |
| Wetland Restoration | 0 | 0 | 0 | 0 | 0 | 0 |
| Retirement of Highly Erodible Land | 2,321,127 | 3,954,102 | 0 | 1,809,053 | -86,601 | 2,407,728 |
| Tree Planting | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Plans | 2,621,314 | 14,048,270 | 801,998 | 0 | 1,029,413 | 1,591,901 |
| Cover Crops | 2,246,571 | 0 | 2,246,571 | 0 | 280,821 | 1,965,750 |
| Stream Protection w/ Fencing | 782,184 | 4,348,670 | 219,012 | 0 | 289,408 | 492,776 |
| Stream Protection w/o Fencing | 319,643 | 1,777,101 | 89,500 | 0 | 118,268 | 201,375 |
| Nutrient Management Plan Implementation[4] | 941,937 | 8,550,427 | 0 | 0 | 117,742 | 824,195 |
| Grazing Land Protection | 1,262,326 | 7,018,088 | 353,451 | 0 | 467,060 | 795,265 |
| Animal Waste Management Systems | 2,182,852 | 9,439,027 | 960,455 | 0 | 1,113,255 | 1,069,598 |
| Yield Reserve[4] | 0 | 0 | 0 | 0 | 0 | 0 |
| Carbon Sequestration | 0 | 0 | 0 | 0 | 0 | 0 |
| Excess Manure Removal | 0 | 0 | 0 | 0 | 0 | 0 |
| Conservation Tillage | 167,524 | 0 | 167,524 | 0 | 167,524 | 0 |
| Total | 14,667,478 | 61,948,298 | 4,993,823 | 2,542,738 | 3,705,333 | 10,962,145 |

| Forest | Total Annual |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 4,089,798 |

| Onsite Wastewater Management Systems | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Denitrification w/ Pumping | 0 | 0 | 0 |

| Point Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Municipal | 6,235,642 | 65,159,566 | 2,055,843 |
| Industrial | 0 | 0 | 0 |
| Total | 6,235,642 | 65,159,566 | 2,055,843 |

| All Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Total | 31,347,921 | 175,475,952 | 9,323,281 |

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

## Exhibit E-36: Estimated Costs of Tier 2: Pennsylvania (2001$)

| Urban | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Forest Buffers | 2,351,317 | 28,168,437 | 352,698 |
| Grass Buffers | 352,798 | 2,724,214 | 0 |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | 0 |
| Storm Water Retrofits | 20,166,570 | 155,818,424 | 7,663,297 |
| Storm Water Management on New Dev. | 3,412,988 | 26,370,696 | 1,296,936 |
| Nutrient Management | 747,517 | 2,035,675 | 0 |
| Urban Land Conversion | 0 | 0 | 0 |
| Forest Conservation | 0 | 0 | 0 |
| Total | 27,031,192 | 215,117,445 | 9,312,930 |

| Agriculture | Total Annual[1] | Capital | Annual O&M | Annual Land Rental[2] | Farmer Share of Annual Cost[3] | Federal/State Share of Annual Cost |
|---|---|---|---|---|---|---|
| Forest Buffers | 12,529,675 | 75,215,200 | 941,771 | 6,251,200 | 651,101 | 11,878,574 |
| Grass Buffers | 3,657,998 | 3,727,866 | 0 | 3,175,222 | -141,993 | 3,799,991 |
| Wetland Restoration | 303,268 | 1,797,060 | 55,012 | 131,355 | 47,602 | 255,666 |
| Retirement of Highly Erodible Land | 19,254,172 | 23,661,964 | 0 | 16,189,839 | -901,274 | 20,155,446 |
| Tree Planting | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Plans | 11,140,394 | 59,484,892 | 3,436,828 | 0 | 3,436,828 | 7,703,566 |
| Cover Crops | 16,610,845 | 0 | 16,610,845 | 0 | 7,382,598 | 9,228,247 |
| Stream Protection w/ Fencing | 3,097,505 | 17,221,042 | 867,301 | 0 | 867,301 | 2,230,204 |
| Stream Protection w/o Fencing | 1,022,835 | 5,686,604 | 286,394 | 0 | 433,682 | 589,153 |
| Nutrient Management Plan Implementation[4] | 5,639,185 | 51,189,665 | 0 | 0 | 1,127,837 | 4,511,348 |
| Grazing Land Protection | 3,238,242 | 18,003,488 | 906,708 | 0 | 1,373,014 | 1,865,227 |
| Animal Waste Management Systems | 13,298,399 | 57,504,561 | 5,851,296 | 0 | 7,340,717 | 5,957,683 |
| Yield Reserve[4] | 0 | 0 | 0 | 0 | 0 | 0 |
| Carbon Sequestration | 0 | 0 | 0 | 0 | 0 | 0 |
| Excess Manure Removal | 406,072 | 0 | 406,072 | 0 | 406,072 | 0 |
| Conservation Tillage | 734,105 | 0 | 734,105 | 0 | 734,105 | 0 |
| Total | 90,932,696 | 313,492,341 | 30,096,333 | 25,747,616 | 22,757,591 | 68,175,104 |

| Forest | Total Annual |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 15,615,323 |

| Onsite Wastewater Management Systems | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Denitrification w/ Pumping | 0 | 0 | 0 |

| Point Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Municipal | 32,014,260 | 354,738,565 | 9,258,800 |
| Industrial | 2,043,399 | 18,123,358 | 493,968 |
| Total | 34,057,659 | 372,861,923 | 9,752,768 |

| All Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Total | 167,636,870 | 901,471,709 | 49,162,031 |

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

# Exhibit E-36: Estimated Costs of Tier 2: Virginia (2001$)

| Urban | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Forest Buffers | 972,497 | 11,650,369 | 145,875 |
| Grass Buffers | 675,841 | 5,218,663 | 0 |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | 0 |
| Storm Water Retrofits | 38,488,376 | 297,383,150 | 14,625,583 |
| Storm Water Management on New Dev. | 17,864,470 | 138,031,087 | 6,788,499 |
| Nutrient Management | 1,264,150 | 3,442,593 | 0 |
| Urban Land Conversion | 0 | 0 | 0 |
| Forest Conservation | 0 | 0 | 0 |
| Total | 59,265,334 | 455,725,862 | 21,559,956 |

| Agriculture | Total Annual[1] | Capital | Annual O&M | Annual Land Rental[2] | Farmer Share of Annual Cost[3] | Federal/State Share of Annual Cost |
|---|---|---|---|---|---|---|
| Forest Buffers | 9,758,239 | 63,154,108 | 790,754 | 4,486,546 | 1,361,854 | 8,396,385 |
| Grass Buffers | 1,494,822 | 1,780,341 | 0 | 1,264,260 | -94,937 | 1,589,760 |
| Wetland Restoration | 479,241 | 2,939,844 | 89,996 | 198,004 | 110,531 | 368,710 |
| Retirement of Highly Erodible Land | 10,418,034 | 12,811,532 | 0 | 8,758,882 | -683,180 | 11,101,214 |
| Tree Planting | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Plans | 13,403,197 | 71,609,558 | 4,129,431 | 0 | 6,447,873 | 6,955,324 |
| Cover Crops | 6,197,876 | 0 | 6,197,876 | 0 | 1,549,469 | 4,648,407 |
| Stream Protection w/ Fencing | 6,274,538 | 34,884,232 | 1,756,871 | 0 | 2,886,288 | 3,388,251 |
| Stream Protection w/o Fencing | 2,140,090 | 11,898,149 | 599,225 | 0 | 984,441 | 1,155,649 |
| Nutrient Management Plan Implementation[4] | 2,900,010 | 26,324,820 | 0 | 0 | 1,657,148 | 1,242,861 |
| Grazing Land Protection | 10,477,739 | 58,252,555 | 2,933,767 | 0 | 4,819,760 | 5,657,979 |
| Animal Waste Management Systems | 2,183,733 | 9,442,837 | 960,843 | 0 | 1,266,565 | 917,168 |
| Yield Reserve[4] | 0 | 0 | 0 | 0 | 0 | 0 |
| Carbon Sequestration | 0 | 0 | 0 | 0 | 0 | 0 |
| Excess Manure Removal | 2,108,290 | 0 | 2,108,290 | 0 | 2,108,290 | 0 |
| Conservation Tillage | 36,521 | 0 | 36,521 | 0 | 36,521 | 0 |
| Total | 67,872,330 | 293,097,977 | 19,603,573 | 14,707,692 | 22,450,623 | 45,421,708 |

| Forest | Total Annual |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 4,077,351 |

| Onsite Wastewater Management Systems | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Denitrification w/ Pumping | 0 | 0 | 0 |

| Point Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Municipal[5] | 60,802,572 | 661,424,265 | 12,563,798 |
| Industrial | 3,411,858 | 15,051,365 | 2,125,063 |
| Total | 64,214,430 | 676,475,630 | 14,688,861 |

| All Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Total | 195,429,445 | 1,425,299,468 | 55,852,391 |

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.
5. Costs for Blue Plains WWTF are allocated to Maryland, Virginia, and the District of Columbia as recommended by MWCOG (2002).

# Exhibit E-36: Estimated Costs of Tier 2: West Virginia (2001$)

| Urban | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Forest Buffers | 42,740 | 512,023 | 6,411 |
| Grass Buffers | 29,703 | 229,355 | 0 |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | 0 |
| Storm Water Retrofits | 1,690,402 | 13,061,008 | 642,353 |
| Storm Water Management on New Dev. | 660,744 | 5,105,287 | 251,083 |
| Nutrient Management | 81,873 | 222,961 | 0 |
| Urban Land Conversion | 0 | 0 | 0 |
| Forest Conservation | 0 | 0 | 0 |
| Total | 2,505,462 | 19,130,634 | 899,847 |

| Agriculture | Total Annual[1] | Capital | Annual O&M | Annual Land Rental[2] | Farmer Share of Annual Cost[3] | Federal/State Share of Annual Cost |
|---|---|---|---|---|---|---|
| Forest Buffers | 1,553,131 | 13,167,381 | 164,869 | 454,004 | 347,548 | 1,205,583 |
| Grass Buffers | 55,979 | 108,997 | 0 | 41,863 | -623 | 56,602 |
| Wetland Restoration | 0 | 0 | 0 | 0 | 0 | 0 |
| Retirement of Highly Erodible Land | 825,639 | 1,836,510 | 0 | 587,803 | -10,493 | 836,132 |
| Tree Planting | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Plans | 2,779,769 | 14,825,029 | 859,860 | 0 | 1,339,837 | 1,439,932 |
| Cover Crops | 327,115 | 0 | 327,115 | 0 | 81,779 | 245,337 |
| Stream Protection w/ Fencing | 2,091,315 | 11,626,979 | 585,568 | 0 | 962,005 | 1,129,310 |
| Stream Protection w/o Fencing | 829,179 | 4,609,942 | 232,170 | 0 | 381,422 | 447,756 |
| Nutrient Management Plan Implementation[4] | 381,612 | 3,464,082 | 0 | 0 | 95,403 | 286,209 |
| Grazing Land Protection | 3,324,960 | 18,485,609 | 930,989 | 0 | 1,529,481 | 1,795,478 |
| Animal Waste Management Systems | 582,122 | 2,517,194 | 256,134 | 0 | 337,631 | 244,491 |
| Yield Reserve[4] | 0 | 0 | 0 | 0 | 0 | 0 |
| Carbon Sequestration | 0 | 0 | 0 | 0 | 0 | 0 |
| Excess Manure Removal | 0 | 0 | 0 | 0 | 0 | 0 |
| Conservation Tillage | -19,807 | 0 | -19,807 | 0 | -19,807 | 0 |
| Total | 12,731,013 | 70,641,723 | 3,336,897 | 1,083,670 | 5,044,183 | 7,686,830 |

| Forest | Total Annual |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 1,494,612 |

| Onsite Wastewater Management Systems | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Denitrification w/ Pumping | 0 | 0 | 0 |

| Point Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Municipal | 1,828,655 | 24,283,876 | 523,247 |
| Industrial | 559,099 | 5,286,279 | 107,156 |
| Total | 2,387,754 | 29,570,155 | 630,403 |

| All Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Total | 19,118,840 | 119,342,512 | 4,867,147 |

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

## Exhibit E-36: Estimated Costs of Tier 3: Delaware (2001$)

| Urban | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Forest Buffers | 36,847 | 441,417 | 5,527 |
| Grass Buffers | 6,723 | 51,915 | 0 |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | 0 |
| Storm Water Retrofits | 1,999,088 | 15,446,093 | 759,653 |
| Storm Water Management on New Dev. | 274,214 | 2,118,737 | 104,201 |
| Nutrient Management | 72,586 | 197,669 | 0 |
| Urban Land Conversion | 0 | 0 | 0 |
| Forest Conservation | 0 | 0 | 0 |
| Total | 2,389,458 | 18,255,831 | 869,382 |

| Agriculture | Total Annual[1] | Capital | Annual O&M | Annual Land Rental[2] | Farmer Share of Annual Cost[3] | Federal/State Share of Annual Cost |
|---|---|---|---|---|---|---|
| Forest Buffers | 1,274,902 | 6,494,628 | 81,319 | 732,773 | 113,822 | 1,161,080 |
| Grass Buffers | 341,376 | 366,849 | 0 | 293,868 | -8,035 | 349,411 |
| Wetland Restoration | 39,594 | 234,183 | 7,169 | 17,191 | 8,108 | 31,486 |
| Retirement of Highly Erodible Land | 1,747,278 | 2,764,430 | 0 | 1,389,271 | -60,545 | 1,807,823 |
| Tree Planting | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Plans | 1,758,609 | 9,484,031 | 530,383 | 0 | 683,912 | 1,074,697 |
| Cover Crops | 2,514,479 | 0 | 2,514,479 | 0 | 628,620 | 1,885,859 |
| Stream Protection w/ Fencing | 87,236 | 485,000 | 24,426 | 0 | 40,128 | 47,107 |
| Stream Protection w/o Fencing | 5,243 | 29,147 | 1,468 | 0 | 2,412 | 2,831 |
| Nutrient Management Plan Implementation[4] | 677,137 | 6,146,711 | 0 | 0 | 360,818 | 316,320 |
| Grazing Land Protection | 60,802 | 338,038 | 17,025 | 0 | 27,969 | 32,833 |
| Animal Waste Management Systems | 44,238 | 191,292 | 19,465 | 0 | 25,658 | 18,580 |
| Yield Reserve[4] | 316,092 | 2,869,325 | 0 | 0 | 0 | 316,092 |
| Carbon Sequestration | 285,037 | 2,200,976 | 0 | 0 | 285,037 | 0 |
| Excess Manure Removal | 262,177 | 0 | 262,177 | 0 | 0 | 262,177 |
| Conservation Tillage | -22,371 | 0 | -22,371 | 0 | -22,371 | 0 |
| Total | 9,391,828 | 31,604,611 | 3,435,539 | 2,433,103 | 2,085,531 | 7,306,297 |

| Forest | Total Annual |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 73,355 |

| Onsite Wastewater Management Systems | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Denitrification w/ Pumping | 181,326 | 951,419 | 88,707 |

| Point Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Municipal | 785,664 | 8,998,705 | 286,998 |
| Industrial | 0 | 0 | 0 |
| Total | 785,664 | 8,998,705 | 286,998 |

| All Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Total | 12,821,630 | 59,810,566 | 4,680,626 |

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

## Exhibit E-36: Estimated Costs of Tier 3: District of Columbia (2001$)

| Urban | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Forest Buffers | 9,401 | 112,628 | 1,410 |
| Grass Buffers | 1,715 | 13,246 | 0 |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | 0 |
| Storm Water Retrofits | 8,308,836 | 64,198,805 | 3,157,358 |
| Storm Water Management on New Dev. | 0 | 0 | 0 |
| Nutrient Management | 26,949 | 73,388 | 0 |
| Urban Land Conversion | 0 | 0 | 0 |
| Forest Conservation | 0 | 0 | 0 |
| Total | 8,346,901 | 64,398,067 | 3,158,768 |

| Agriculture | Total Annual[1] | Capital | Annual O&M | Annual Land Rental[2] | Farmer Share of Annual Cost[3] | Federal/State Share of Annual Cost |
|---|---|---|---|---|---|---|
| Forest Buffers | 0 | 0 | 0 | 0 | 0 | 0 |
| Grass Buffers | 0 | 0 | 0 | 0 | 0 | 0 |
| Wetland Restoration | 0 | 0 | 0 | 0 | 0 | 0 |
| Retirement of Highly Erodible Land | 0 | 0 | 0 | 0 | 0 | 0 |
| Tree Planting | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Plans | 0 | 0 | 0 | 0 | 0 | 0 |
| Cover Crops | 0 | 0 | 0 | 0 | 0 | 0 |
| Stream Protection w/ Fencing | 0 | 0 | 0 | 0 | 0 | 0 |
| Stream Protection w/o Fencing | 0 | 0 | 0 | 0 | 0 | 0 |
| Nutrient Management Plan Implementation[4] | 0 | 0 | 0 | 0 | 0 | 0 |
| Grazing Land Protection | 0 | 0 | 0 | 0 | 0 | 0 |
| Animal Waste Management Systems | 0 | 0 | 0 | 0 | 0 | 0 |
| Yield Reserve[4] | 0 | 0 | 0 | 0 | 0 | 0 |
| Carbon Sequestration | 0 | 0 | 0 | 0 | 0 | 0 |
| Excess Manure Removal | 0 | 0 | 0 | 0 | 0 | 0 |
| Conservation Tillage | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 0 | 0 | 0 | 0 | 0 | 0 |

| Forest | Total Annual |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 0 |

| Onsite Wastewater Management Systems | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Denitrification w/ Pumping | 33,087 | 173,609 | 16,187 |

| Point Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Municipal[5] | 18,779,834 | 127,268,400 | 10,692,850 |
| Industrial | 0 | 0 | 0 |
| Total | 18,779,834 | 127,268,400 | 10,692,850 |

| All Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Total | 27,159,823 | 191,840,076 | 13,867,805 |

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.
5. Costs for Blue Plains WWTF are allocated to Maryland, Virginia, and the District of Columbia as recommended by MWCOG (2002).

# Exhibit E-36: Estimated Costs of Tier 3: Maryland (2001$)

| Urban | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Forest Buffers | 1,886,731 | 22,602,757 | 283,010 |
| Grass Buffers | 232,846 | 1,797,978 | 0 |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | 0 |
| Storm Water Retrofits | 104,843,384 | 810,079,790 | 39,840,486 |
| Storm Water Management on New Dev. | 11,069,443 | 85,528,832 | 4,206,388 |
| Nutrient Management | 1,507,955 | 4,106,536 | 0 |
| Urban Land Conversion | 0 | 0 | 0 |
| Forest Conservation | 0 | 0 | 0 |
| Total | 119,540,360 | 924,115,893 | 44,329,884 |

| Agriculture | Total Annual[1] | Capital | Annual O&M | Annual Land Rental[2] | Farmer Share of Annual Cost[3] | Federal/State Share of Annual Cost |
|---|---|---|---|---|---|---|
| Forest Buffers | 10,880,555 | 64,813,373 | 811,530 | 5,470,358 | -394,193 | 11,274,748 |
| Grass Buffers | 3,370,826 | 3,692,917 | 0 | 2,892,576 | -362,204 | 3,733,029 |
| Wetland Restoration | 1,922,412 | 12,004,531 | 367,488 | 774,012 | 316,602 | 1,605,810 |
| Retirement of Highly Erodible Land | 15,681,537 | 18,382,523 | 0 | 13,300,917 | -1,802,970 | 17,484,508 |
| Tree Planting | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Plans | -2,704,391 | -14,744,417 | -794,922 | 0 | -1,033,605 | -1,670,786 |
| Cover Crops | 12,885,030 | 0 | 12,885,030 | 0 | 3,340,563 | 9,544,467 |
| Stream Protection w/ Fencing | 2,873,335 | 15,974,733 | 804,534 | 0 | 1,063,134 | 1,810,201 |
| Stream Protection w/o Fencing | 163,730 | 910,283 | 45,844 | 0 | 60,580 | 103,150 |
| Nutrient Management Plan Implementation[4] | -2,764,411 | -25,093,921 | 0 | 0 | -1,974,579 | -789,832 |
| Grazing Land Protection | 2,428,946 | 13,504,087 | 680,105 | 0 | 898,710 | 1,530,236 |
| Animal Waste Management Systems | 863,919 | 3,735,733 | 380,124 | 0 | 440,599 | 423,320 |
| Yield Reserve[4] | 2,296,770 | 20,848,914 | 0 | 0 | 0 | 2,296,770 |
| Carbon Sequestration | 1,850,941 | 14,292,475 | 0 | 0 | 1,850,941 | 0 |
| Excess Manure Removal | -8,577 | 0 | -8,577 | 0 | 0 | -8,577 |
| Conservation Tillage | -132,705 | 0 | -132,705 | 0 | -132,705 | 0 |
| Total | 49,607,917 | 128,321,230 | 15,038,451 | 22,437,863 | 2,270,873 | 47,337,045 |

| Forest | Total Annual |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 1,990,659 |

| Onsite Wastewater Management Systems | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Denitrification w/ Pumping | 3,250,804 | 17,057,048 | 1,590,344 |

| Point Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Municipal[5] | 72,428,318 | 778,030,840 | 23,923,215 |
| Industrial | 2,698,833 | 18,350,440 | 1,129,987 |
| Total | 75,127,151 | 796,381,280 | 25,053,203 |

| All Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Total | 249,516,891 | 1,865,875,452 | 86,011,882 |

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.
5. Costs for Blue Plains WWTF are allocated to Maryland, Virginia, and the District of Columbia as recommended by MWCOG (2002).

## Exhibit E-36: Estimated Costs of Tier 3: New York (2001$)

| Urban | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Forest Buffers | 310,119 | 3,715,185 | 46,518 |
| Grass Buffers | 56,586 | 436,939 | 0 |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | 0 |
| Storm Water Retrofits | 20,165,554 | 155,810,576 | 7,662,911 |
| Storm Water Management on New Dev. | 600,322 | 4,638,434 | 228,123 |
| Nutrient Management | 449,237 | 1,223,383 | 0 |
| Urban Land Conversion | 0 | 0 | 0 |
| Forest Conservation | 0 | 0 | 0 |
| Total | 21,581,819 | 165,824,517 | 7,937,551 |

| Agriculture | Total Annual[1] | Capital | Annual O&M | Annual Land Rental[2] | Farmer Share of Annual Cost[3] | Federal/State Share of Annual Cost |
|---|---|---|---|---|---|---|
| Forest Buffers | 2,715,428 | 21,232,593 | 265,854 | 943,070 | 372,113 | 2,343,315 |
| Grass Buffers | 415,873 | 714,838 | 0 | 323,298 | -15,656 | 431,529 |
| Wetland Restoration | 0 | 0 | 0 | 0 | 0 | 0 |
| Retirement of Highly Erodible Land | 3,722,815 | 6,389,951 | 0 | 2,895,287 | -139,950 | 3,862,765 |
| Tree Planting | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Plans | 5,747,569 | 30,775,278 | 1,762,030 | 0 | 2,260,222 | 3,487,347 |
| Cover Crops | 3,355,143 | 0 | 3,355,143 | 0 | 419,393 | 2,935,750 |
| Stream Protection w/ Fencing | 3,884,525 | 21,596,594 | 1,087,667 | 0 | 1,437,274 | 2,447,250 |
| Stream Protection w/o Fencing | 233,445 | 1,297,872 | 65,365 | 0 | 86,375 | 147,070 |
| Nutrient Management Plan Implementation[4] | 974,582 | 8,846,765 | 0 | 0 | 121,823 | 852,760 |
| Grazing Land Protection | 2,300,132 | 12,787,924 | 644,037 | 0 | 851,049 | 1,449,083 |
| Animal Waste Management Systems | 3,822,385 | 16,528,648 | 1,681,849 | 0 | 1,949,416 | 1,872,969 |
| Yield Reserve[4] | 483,087 | 4,385,221 | 0 | 0 | 0 | 483,087 |
| Carbon Sequestration | 380,103 | 2,935,057 | 0 | 0 | 380,103 | 0 |
| Excess Manure Removal | 0 | 0 | 0 | 0 | 0 | 0 |
| Conservation Tillage | 237,254 | 0 | 237,254 | 0 | 237,254 | 0 |
| Total | 28,272,341 | 127,490,741 | 9,099,198 | 4,161,655 | 7,959,416 | 20,312,925 |

| Forest | Total Annual |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 4,544,220 |

| Onsite Wastewater Management Systems | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Denitrification w/ Pumping | 1,131,503 | 5,937,023 | 553,549 |

| Point Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Municipal | 10,184,157 | 105,760,184 | 3,399,944 |
| Industrial | 0 | 0 | 0 |
| Total | 10,184,157 | 105,760,184 | 3,399,944 |

| All Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Total | 65,714,039 | 405,012,465 | 20,990,242 |

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

## Exhibit E-36: Estimated Costs of Tier 3: Pennsylvania (2001$)

| Urban | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Forest Buffers | 3,372,590 | 40,403,133 | 505,889 |
| Grass Buffers | 273,498 | 2,111,882 | 0 |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | 0 |
| Storm Water Retrofits | 80,640,209 | 623,072,254 | 30,643,279 |
| Storm Water Management on New Dev. | 1,971,034 | 15,229,335 | 748,993 |
| Nutrient Management | 1,442,580 | 3,928,502 | 0 |
| Urban Land Conversion | 0 | 0 | 0 |
| Forest Conservation | 0 | 0 | 0 |
| Total | 87,699,911 | 684,745,106 | 31,898,161 |

| Agriculture | Total Annual[1] | Capital | Annual O&M | Annual Land Rental[2] | Farmer Share of Annual Cost[3] | Federal/State Share of Annual Cost |
|---|---|---|---|---|---|---|
| Forest Buffers | 21,111,400 | 126,820,710 | 1,587,925 | 10,525,234 | 1,097,825 | 20,013,575 |
| Grass Buffers | 6,371,405 | 6,496,114 | 0 | 5,530,128 | -247,434 | 6,618,839 |
| Wetland Restoration | 528,432 | 3,122,939 | 95,601 | 229,680 | 82,724 | 445,709 |
| Retirement of Highly Erodible Land | 30,058,820 | 36,977,925 | 0 | 25,270,009 | -1,408,474 | 31,467,293 |
| Tree Planting | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Plans | 15,876,265 | 84,680,815 | 4,909,712 | 0 | 4,909,712 | 10,966,553 |
| Cover Crops | 24,719,849 | 0 | 24,719,849 | 0 | 10,986,599 | 13,733,249 |
| Stream Protection w/ Fencing | 12,508,191 | 69,541,155 | 3,502,294 | 0 | 3,502,294 | 9,005,898 |
| Stream Protection w/o Fencing | 746,558 | 4,150,602 | 209,036 | 0 | 316,541 | 430,018 |
| Nutrient Management Plan Implementation[4] | 3,849,996 | 34,948,310 | 0 | 0 | 769,999 | 3,079,996 |
| Grazing Land Protection | 6,335,106 | 35,220,968 | 1,773,830 | 0 | 2,686,085 | 3,649,021 |
| Animal Waste Management Systems | 16,622,917 | 71,880,344 | 7,314,083 | 0 | 9,175,850 | 7,447,067 |
| Yield Reserve[4] | 3,544,743 | 32,177,379 | 0 | 0 | 0 | 3,544,743 |
| Carbon Sequestration | 2,800,506 | 21,624,763 | 0 | 0 | 2,800,506 | 0 |
| Excess Manure Removal | 685,345 | 0 | 685,345 | 0 | 685,345 | 0 |
| Conservation Tillage | 821,257 | 0 | 821,257 | 0 | 821,257 | 0 |
| Total | 146,580,789 | 527,642,024 | 45,618,932 | 41,555,051 | 36,178,828 | 110,401,961 |

| Forest | Total Annual |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 17,350,359 |

| Onsite Wastewater Management Systems | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Denitrification w/ Pumping | 4,106,021 | 21,544,394 | 2,008,730 |

| Point Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Municipal | 60,264,894 | 674,549,971 | 16,994,450 |
| Industrial | 4,136,284 | 35,078,315 | 1,137,311 |
| Total | 64,401,177 | 709,628,286 | 18,131,761 |

| All Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Total | 320,138,258 | 1,943,559,810 | 97,657,584 |

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

# Exhibit E-36: Estimated Costs of Tier 3: Virginia (2001$)

| Urban | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Forest Buffers | 2,863,404 | 34,303,155 | 429,511 |
| Grass Buffers | 522,468 | 4,034,356 | 0 |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | 0 |
| Storm Water Retrofits | 153,911,083 | 1,189,204,823 | 58,486,212 |
| Storm Water Management on New Dev. | 10,814,275 | 83,557,256 | 4,109,424 |
| Nutrient Management | 2,391,345 | 6,512,225 | 0 |
| Urban Land Conversion | 0 | 0 | 0 |
| Forest Conservation | 0 | 0 | 0 |
| Total | 170,502,574 | 1,317,611,815 | 63,025,147 |

| Agriculture | Total Annual[1] | Capital | Annual O&M | Annual Land Rental[2] | Farmer Share of Annual Cost[3] | Federal/State Share of Annual Cost |
|---|---|---|---|---|---|---|
| Forest Buffers | 15,165,870 | 97,987,186 | 1,226,900 | 6,986,538 | 2,112,994 | 13,052,876 |
| Grass Buffers | 2,483,348 | 2,966,709 | 0 | 2,099,145 | -158,201 | 2,641,549 |
| Wetland Restoration | 764,019 | 4,708,912 | 144,151 | 313,546 | 177,044 | 586,975 |
| Retirement of Highly Erodible Land | 16,416,047 | 20,185,401 | 0 | 13,801,946 | -1,076,395 | 17,492,442 |
| Tree Planting | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Plans | 18,557,806 | 98,973,867 | 5,740,238 | 0 | 8,944,630 | 9,613,176 |
| Cover Crops | 9,605,252 | 0 | 9,605,252 | 0 | 2,401,313 | 7,203,939 |
| Stream Protection w/ Fencing | 27,030,520 | 150,280,207 | 7,568,546 | 0 | 12,434,039 | 14,596,481 |
| Stream Protection w/o Fencing | 1,562,660 | 8,687,842 | 437,545 | 0 | 718,824 | 843,836 |
| Nutrient Management Plan Implementation[4] | 1,710,724 | 15,529,089 | 0 | 0 | 977,557 | 733,168 |
| Grazing Land Protection | 17,968,738 | 99,899,881 | 5,031,247 | 0 | 8,265,620 | 9,703,119 |
| Animal Waste Management Systems | 2,818,268 | 12,186,672 | 1,240,038 | 0 | 1,634,595 | 1,183,672 |
| Yield Reserve[4] | 2,056,859 | 18,671,127 | 0 | 0 | 0 | 2,056,859 |
| Carbon Sequestration | 1,233,866 | 9,527,582 | 0 | 0 | 1,233,866 | 0 |
| Excess Manure Removal | 926,890 | 0 | 926,890 | 0 | 926,890 | 0 |
| Conservation Tillage | -48,363 | 0 | -48,363 | 0 | -48,363 | 0 |
| Total | 118,252,504 | 539,604,475 | 31,872,443 | 23,201,175 | 38,544,411 | 79,708,093 |

| Forest | Total Annual |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 5,135,459 |

| Onsite Wastewater Management Systems | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Denitrification w/ Pumping | 3,944,432 | 20,696,534 | 1,929,678 |

| Point Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Municipal[5] | 105,601,337 | 1,017,739,722 | 31,375,884 |
| Industrial | 7,923,629 | 38,575,094 | 4,625,704 |
| Total | 113,524,966 | 1,056,314,816 | 36,001,588 |

| All Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Total | 411,359,936 | 2,934,227,639 | 132,828,856 |

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.
5. Costs for Blue Plains WWTF are allocated to Maryland, Virginia, and the District of Columbia as recommended by MWCOG (2002).

# Exhibit E-36: Estimated Costs of Tier 3: West Virginia (2001$)

| Urban | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Forest Buffers | 126,608 | 1,516,750 | 18,991 |
| Grass Buffers | 23,101 | 178,383 | 0 |
| Environmental Site Design / Low-Impact Dev. | 0 | 0 | 0 |
| Storm Water Retrofits | 6,761,607 | 52,244,033 | 2,569,411 |
| Storm Water Management on New Dev. | 440,496 | 3,403,525 | 167,389 |
| Nutrient Management | 155,724 | 424,074 | 0 |
| Urban Land Conversion | 0 | 0 | 0 |
| Forest Conservation | 0 | 0 | 0 |
| Total | 7,507,537 | 57,766,765 | 2,755,790 |

| Agriculture | Total Annual[1] | Capital | Annual O&M | Annual Land Rental[2] | Farmer Share of Annual Cost[3] | Federal/State Share of Annual Cost |
|---|---|---|---|---|---|---|
| Forest Buffers | 2,497,590 | 21,113,284 | 264,360 | 735,191 | 557,277 | 1,940,313 |
| Grass Buffers | 77,029 | 149,985 | 0 | 57,606 | -857 | 77,886 |
| Wetland Restoration | 0 | 0 | 0 | 0 | 0 | 0 |
| Retirement of Highly Erodible Land | 1,187,708 | 2,641,877 | 0 | 845,573 | -15,094 | 1,202,802 |
| Tree Planting | 0 | 0 | 0 | 0 | 0 | 0 |
| Farm Plans | 2,600,177 | 13,857,990 | 805,504 | 0 | 1,254,172 | 1,346,005 |
| Cover Crops | 462,929 | 0 | 462,929 | 0 | 115,732 | 347,196 |
| Stream Protection w/ Fencing | 10,114,560 | 56,233,407 | 2,832,077 | 0 | 4,652,698 | 5,461,863 |
| Stream Protection w/o Fencing | 603,851 | 3,357,199 | 169,078 | 0 | 277,771 | 326,079 |
| Nutrient Management Plan Implementation[4] | 343,079 | 3,114,295 | 0 | 0 | 85,770 | 257,309 |
| Grazing Land Protection | 5,063,244 | 28,149,858 | 1,417,708 | 0 | 2,329,092 | 2,734,152 |
| Animal Waste Management Systems | 972,065 | 4,203,377 | 427,709 | 0 | 563,798 | 408,267 |
| Yield Reserve[4] | 206,059 | 1,870,497 | 0 | 0 | 0 | 206,059 |
| Carbon Sequestration | 72,145 | 557,087 | 0 | 0 | 72,145 | 0 |
| Excess Manure Removal | 0 | 0 | 0 | 0 | 0 | 0 |
| Conservation Tillage | -24,525 | 0 | -24,525 | 0 | -24,525 | 0 |
| Total | 24,175,910 | 135,248,854 | 6,354,839 | 1,638,369 | 9,867,979 | 14,307,931 |

| Forest | Total Annual |
|---|---|
| Forest Harvesting Practices (Erosion Control) | 1,660,679 |

| Onsite Wastewater Management Systems | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Denitrification w/ Pumping | 379,196 | 1,989,648 | 185,508 |

| Point Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Municipal | 2,620,379 | 35,255,533 | 725,177 |
| Industrial | 611,642 | 5,736,257 | 121,229 |
| Total | 3,232,021 | 40,991,790 | 846,406 |

| All Sources | Total Annual | Capital | Annual O&M |
|---|---|---|---|
| Total | 36,955,343 | 235,997,058 | 10,142,544 |

Notes: Totals may not add due to rounding. Federal and State cost estimates reflect potential cost sharing through identified programs. Annual cost is calculated as annualized capital cost, plus annual O&M and land rental where applicable.

1. Total annual cost equals annual farmer cost plus annual Federal/State cost. Negative values for total annual cost reflect the conversion of land from agriculture to another use.
2. Total annual cost includes land rental payments paid to farmers by Federal/State cost share programs.
3. Negative values for farmer costs reflect that agricultural producers experience a cost savings due to Federal/State contributions.
4. Capital costs for nutrient management plans and yield reserve are multiplied by 10/3 to represent capital costs over 10 years.

## Exhibit E-37: Cumulative Point Source Facility Costs by Tier

| Facility | NPDES | Tier 1 Costs | | | Tier 2 Costs | | | Tier 3 Costs | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] |
| **Municipal Facilities[2]** | | | | | | | | | | |
| Blue Plains[3] | DC0021199 | $0 | $0 | $0 | $53,000,000 | $8,900,000 | $12,182,112 | $278,000,000 | $22,300,000 | $39,515,604 |
| **Blue Plains Subtotal** | | **$0** | **$0** | **$0** | **$53,000,000** | **$8,900,000** | **$12,182,112** | **$278,000,000** | **$22,300,000** | **$39,515,604** |
| Bridgeville | DE0020249 | $3,187,400 | $63,244 | $239,875 | $3,328,511 | $74,132 | $258,583 | $4,246,599 | $82,065 | $317,392 |
| Laurel | DE0020125 | $0 | $0 | $0 | $2,487,286 | $155,049 | $292,882 | $3,115,256 | $167,481 | $340,114 |
| Seaford | DE0020265 | $0 | $0 | $0 | $0 | $1,346 | $1,346 | $1,636,850 | $37,452 | $128,158 |
| **DE Subtotal** | | **$3,187,400** | **$63,244** | **$239,875** | **$5,815,797** | **$230,527** | **$552,811** | **$8,998,705** | **$286,998** | **$785,664** |
| Aberdeen | MD0021563 | $0 | $0 | $0 | $0 | $0 | $0 | $2,408,870 | $31,281 | $181,458 |
| Aberdeen Proving Grounds - Aberdeen | MD0021237 | $8,000,000 | $159,146 | $657,893 | $8,000,000 | $159,146 | $657,893 | $9,945,658 | $177,594 | $797,640 |
| Aberdeen Proving Grounds - Edgewood | MD0021229 | $0 | $0 | $0 | $0 | $0 | $0 | $2,022,860 | $18,942 | $145,054 |
| Annapolis | MD0021814 | $0 | $0 | $0 | $0 | $0 | $0 | $4,724,930 | $115,245 | $409,814 |
| Back River | MD0021555 | $0 | $0 | $0 | $10,000,000 | $141,129 | $764,564 | $80,346,630 | $1,324,454 | $6,333,537 |
| Ballenger Creek | MD0021822 | $0 | $0 | $0 | $0 | $0 | $0 | $3,180,890 | $68,203 | $266,511 |
| Bowie | MD0021628 | $0 | $0 | $0 | $0 | $0 | $0 | $2,138,663 | $39,949 | $173,280 |
| Broadneck | MD0021644 | $0 | $0 | $0 | $0 | $0 | $0 | $3,180,890 | $86,565 | $284,873 |
| Broadwater | MD0024350 | $0 | $0 | $0 | $0 | $0 | $0 | $1,636,850 | $29,571 | $131,618 |
| Brunswick | MD0020958 | $4,900,000 | $10,928 | $316,411 | $5,031,667 | $26,158 | $339,850 | $5,853,049 | $54,031 | $418,930 |
| Cambridge | MD0021636 | $9,934,376 | $198,241 | $817,584 | $10,202,097 | $276,373 | $912,407 | $14,193,608 | $384,365 | $1,269,243 |
| Celanese | MD0063878 | $5,791,500 | $116,260 | $477,322 | $5,955,293 | $132,288 | $503,562 | $7,302,636 | $166,835 | $622,106 |
| Centreville | MD0020834 | $5,065,400 | $101,583 | $417,378 | $5,166,373 | $108,828 | $430,917 | $5,673,460 | $123,721 | $477,423 |
| Chesapeake Beach | MD0020281 | $0 | $0 | $0 | $0 | $0 | $0 | $1,320,322 | $27,209 | $109,522 |
| Chestertown | MD0020010 | $2,600,000 | $51,782 | $213,875 | $2,750,556 | $72,832 | $244,311 | $3,765,350 | $95,782 | $330,526 |
| Conococheague | MD0063509 | $5,555,439 | $111,577 | $457,922 | $5,555,439 | $113,273 | $459,618 | $8,002,910 | $138,843 | $637,772 |
| Cox Creek | MD0021661 | $9,476,780 | $198,973 | $789,788 | $9,476,780 | $227,145 | $817,960 | $16,131,760 | $473,729 | $1,479,438 |
| Crisfield | MD0020001 | $4,052,200 | $80,139 | $332,767 | $4,212,200 | $89,073 | $351,676 | $5,323,700 | $112,586 | $444,484 |
| Cumberland | MD0021598 | $0 | $0 | $0 | $0 | $58,071 | $58,071 | $6,654,980 | $250,533 | $665,428 |
| Damascus | MD0020982 | $0 | $0 | $0 | $0 | $830 | $830 | $1,443,845 | $27,892 | $117,906 |
| Delmar | MD0020532 | $1,030,000 | $19,833 | $84,047 | $1,030,000 | $19,833 | $84,047 | $1,803,029 | $38,128 | $150,535 |

## Exhibit E-37: Cumulative Point Source Facility Costs by Tier

| Facility | NPDES | Tier 1 Costs | | | Tier 2 Costs | | | Tier 3 Costs | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] |
| Denton | MD0020494 | $0 | $0 | $0 | $0 | $1,268 | $1,268 | $918,088 | $15,878 | $73,114 |
| Dorsey Run | MD0063207 | $0 | $0 | $0 | $0 | $0 | $0 | $1,636,850 | $33,574 | $135,621 |
| Easton | MD0020273 | $0 | $0 | $0 | $180,482 | $29,019 | $40,271 | $1,952,436 | $80,843 | $202,564 |
| Elkton | MD0020681 | $6,360,000 | $128,234 | $524,738 | $6,360,000 | $129,486 | $525,990 | $8,267,057 | $174,147 | $689,544 |
| Emmitsburg | MD0020257 | $0 | $0 | $0 | $0 | $4,669 | $4,669 | $869,735 | $25,569 | $79,791 |
| Federalsburg | MD0020249 | $1,500,000 | $29,282 | $122,797 | $1,500,000 | $29,282 | $122,797 | $2,369,735 | $41,099 | $188,836 |
| Fort Detrick | MD0020877 | $0 | $0 | $0 | $0 | $1,573 | $1,573 | $1,636,850 | $32,933 | $134,980 |
| Fort Meade | MD0021717 | $0 | $0 | $0 | $0 | $0 | $0 | $2,601,875 | $38,252 | $200,461 |
| Frederick | MD0021610 | $8,816,824 | $153,316 | $702,987 | $9,083,028 | $363,567 | $929,834 | $13,035,938 | $527,825 | $1,340,529 |
| Freedom District | MD0021512 | $0 | $0 | $0 | $0 | $0 | $0 | $2,215,865 | $59,144 | $197,288 |
| Fruitland | MD0052990 | $6,200,000 | $124,549 | $511,078 | $6,312,778 | $135,363 | $528,923 | $6,940,748 | $155,657 | $588,367 |
| Georges Creek | MD0060071 | $2,000,000 | $40,709 | $165,396 | $2,122,222 | $54,211 | $186,517 | $2,846,898 | $79,406 | $256,891 |
| Hagerstown | MD0021776 | $0 | $0 | $0 | $266,204 | $97,440 | $114,036 | $4,219,114 | $276,630 | $539,664 |
| Havre de Grace | MD0021750 | $6,278,550 | $125,354 | $516,781 | $6,278,550 | $125,354 | $516,781 | $7,872,939 | $164,028 | $654,854 |
| Hurtlock | MD0022730 | $5,200,000 | $103,378 | $427,564 | $5,375,172 | $161,003 | $496,110 | $7,012,022 | $191,041 | $628,194 |
| Indian Head | MD0020052 | $656,000 | $12,603 | $53,500 | $768,778 | $19,317 | $67,245 | $1,396,748 | $33,133 | $120,211 |
| Joppatowne | MD0022535 | $0 | $0 | $0 | $0 | $0 | $0 | $1,063,147 | $28,048 | $94,328 |
| Kent Island | MD0023485 | $20,742,570 | $415,470 | $1,708,632 | $20,742,570 | $415,470 | $1,708,632 | $22,431,531 | $455,906 | $1,854,364 |
| La Plata | MD0020524 | $4,120,970 | $82,823 | $339,739 | $4,120,970 | $86,854 | $343,769 | $5,232,470 | $115,393 | $441,603 |
| Leonardtown | MD0024767 | $1,840,000 | $37,068 | $151,779 | $1,969,778 | $47,515 | $170,318 | $2,771,819 | $65,222 | $238,027 |
| Little Paxutent | MD0055174 | $0 | $0 | $0 | $0 | $0 | $0 | $9,550,055 | $293,557 | $888,940 |
| Maryland City | MD0062596 | $0 | $0 | $0 | $0 | $0 | $0 | $1,829,855 | $22,344 | $136,423 |
| Maryland Correctional Institute | MD0023957 | $0 | $0 | $0 | $0 | $0 | $0 | $1,339,622 | $27,220 | $110,736 |
| Mattawoman | MD0021865 | $7,935,800 | $162,078 | $656,823 | $7,935,800 | $162,078 | $656,823 | $14,590,780 | $281,809 | $1,191,448 |
| Mounty Airy | MD0022527 | $0 | $0 | $0 | $0 | $0 | $0 | $1,328,042 | $19,228 | $102,023 |
| Northeast River | MD0052027 | $1,800,000 | $35,703 | $147,921 | $1,800,000 | $35,703 | $147,921 | $3,436,850 | $53,085 | $267,350 |
| Parkway | MD0021725 | $0 | $0 | $0 | $0 | $0 | $0 | $3,759,905 | $98,699 | $333,104 |
| Patapsco | MD0021601 | $200,000,000 | $4,067,523 | $16,536,207 | $200,000,000 | $4,067,523 | $16,536,207 | $229,043,560 | $5,248,210 | $19,527,569 |
| Patuxent | MD0021652 | $0 | $0 | $0 | $0 | $0 | $0 | $3,759,905 | $77,129 | $311,535 |
| Perryville | MD0020613 | $0 | $0 | $0 | $0 | $0 | $0 | $1,501,746 | $23,358 | $116,982 |

## Exhibit E-37: Cumulative Point Source Facility Costs by Tier

| Facility | NPDES | Tier 1 Costs | | | Tier 2 Costs | | | Tier 3 Costs | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] |
| Pine Hill Run | MD0021679 | $0 | $0 | $0 | $0 | $11,611 | $11,611 | $3,180,890 | $97,071 | $295,379 |
| Piscataway | MD0021539 | $0 | $0 | $0 | $0 | $0 | $0 | $12,445,130 | $354,631 | $1,130,503 |
| Pocomoke City | MD0022551 | $2,700,000 | $200,000 | $368,327 | $2,866,069 | $229,233 | $407,914 | $4,271,313 | $260,371 | $526,659 |
| Poolesville | MD0023001 | $1,658,000 | $33,147 | $136,513 | $1,658,000 | $33,147 | $136,513 | $2,406,853 | $56,990 | $207,041 |
| Princess Anne | MD0020656 | $3,563,500 | $70,685 | $292,846 | $3,563,500 | $70,685 | $292,846 | $4,914,703 | $88,335 | $394,734 |
| Salisbury | MD0021571 | $15,000,000 | $303,495 | $1,238,646 | $15,000,000 | $322,608 | $1,257,759 | $18,489,698 | $449,846 | $1,602,557 |
| Seneca Creek | MD0021491 | $29,520,000 | $566,020 | $2,406,398 | $29,520,000 | $611,888 | $2,452,266 | $32,314,880 | $1,036,593 | $3,051,213 |
| Snow Hill | MD0022764 | $1,600,000 | $32,017 | $131,767 | $1,712,778 | $44,864 | $151,645 | $2,340,748 | $63,097 | $209,027 |
| Sod Run | MD0056545 | $0 | $0 | $0 | $0 | $17,662 | $17,662 | $8,585,030 | $266,222 | $801,442 |
| Taneytown | MD0020672 | $0 | $0 | $0 | $0 | $5,741 | $5,741 | $1,289,441 | $38,594 | $118,982 |
| Thurmont | MD0021121 | $0 | $0 | $0 | $0 | $0 | $0 | $1,111,500 | $31,478 | $100,773 |
| Western Branch | MD0021741 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $39,020 | $39,020 |
| Westminster | MD0021831 | $0 | $0 | $0 | $0 | $0 | $0 | $2,794,880 | $75,140 | $249,382 |
| Winebrenner WWTP | MD0003221 | $852,000 | $16,578 | $69,695 | $852,000 | $17,992 | $71,109 | $1,963,500 | $25,635 | $148,046 |
| **MD Subtotal** | | **$384,749,909** | **$7,788,496** | **$31,775,121** | **$397,369,083** | **$8,757,110** | **$33,530,457** | **$650,595,640** | **$15,406,845** | **$55,967,202** |
| Addison (V) | NY0020320 | $0 | $0 | $0 | $2,423,823 | $55,047 | $210,528 | $2,974,428 | $64,674 | $255,475 |
| Bath (V) | NY0021431 | $0 | $0 | $0 | $2,882,193 | $69,643 | $254,528 | $3,993,693 | $95,930 | $352,114 |
| Binghampton-Johnson City Borough | NY0024414 | $0 | $0 | $0 | $448,268 | $175,305 | $204,060 | $9,033,298 | $560,856 | $1,140,316 |
| Cooperstown | NY0023591 | $0 | $0 | $0 | $2,503,139 | $59,398 | $219,967 | $3,150,451 | $84,551 | $286,643 |
| Corning (C) | NY0025721 | $0 | $0 | $0 | $3,674,079 | $92,485 | $328,166 | $5,361,111 | $128,446 | $472,346 |
| Cortland (C) | NY0027561 | $0 | $0 | $0 | $0 | $21,404 | $21,404 | $4,724,930 | $197,711 | $500,802 |
| Elmira/Chemung Co. SD #2 | NY0035742 | $0 | $0 | $0 | $9,940,841 | $306,780 | $944,457 | $15,437,791 | $453,234 | $1,443,524 |
| Endicott (V) | NY0027669 | $0 | $0 | $0 | $6,952,548 | $264,880 | $710,866 | $6,952,548 | $305,815 | $751,801 |
| Hamilton (V) | NY0020672 | $0 | $0 | $0 | $2,764,035 | $61,060 | $238,365 | $3,730,476 | $76,967 | $316,266 |
| Hornell (C) | NY0023647 | $0 | $0 | $0 | $4,950,960 | $143,886 | $461,476 | $7,359,830 | $214,750 | $686,862 |
| Lake Street/Chemung Co. SD #1 | NY0036986 | $0 | $0 | $0 | $8,463,821 | $271,098 | $814,028 | $12,995,746 | $419,040 | $1,252,680 |
| Norwich | NY0021423 | $0 | $0 | $0 | $3,722,631 | $108,573 | $347,369 | $5,436,683 | $182,064 | $530,812 |
| Oneonta (C) | NY0031151 | $0 | $0 | $0 | $4,950,960 | $117,700 | $435,290 | $7,359,830 | $188,494 | $660,606 |
| Owego #2 | NY0025798 | $0 | $0 | $0 | $175,172 | $16,282 | $27,519 | $1,812,022 | $45,739 | $161,975 |
| Owego (V) | NY0029262 | $0 | $0 | $0 | $2,882,193 | $66,970 | $251,854 | $3,993,693 | $88,561 | $344,744 |

## Exhibit E-37: Cumulative Point Source Facility Costs by Tier

| Facility | NPDES | Tier 1 Costs | | | Tier 2 Costs | | | Tier 3 Costs | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] |
| Richfield Springs (V) | NY0031411 | $0 | $0 | $0 | $2,444,284 | $48,320 | $205,114 | $3,168,960 | $58,719 | $261,999 |
| Sidney (V) | NY0029271 | $0 | $0 | $0 | $3,374,544 | $107,065 | $323,532 | $4,895,591 | $127,000 | $441,038 |
| Waverly (V) | NY0031089 | $0 | $0 | $0 | $2,606,072 | $69,949 | $237,121 | $3,379,101 | $107,394 | $324,154 |
| **NY Subtotal** | | **$0** | **$0** | **$0** | **$65,159,566** | **$2,055,843** | **$6,235,642** | **$105,760,184** | **$3,399,944** | **$10,184,157** |
| Altoona City Authority (East) | PA0027014 | $0 | $0 | $0 | $1,428,274 | $184,710 | $276,329 | $9,758,274 | $500,170 | $1,126,136 |
| Altoona City Authority (West) | PA0027022 | $0 | $0 | $0 | $1,481,376 | $188,463 | $283,489 | $13,011,376 | $479,656 | $1,314,298 |
| Annville Twp | PA0021806 | $0 | $0 | $0 | $2,548,725 | $51,066 | $214,559 | $3,418,460 | $68,242 | $287,526 |
| Antrim Twp | PA0080519 | $0 | $0 | $0 | $160,759 | $7,913 | $18,225 | $1,430,899 | $26,204 | $117,992 |
| Ashland Municipal | PA0023558 | $0 | $0 | $0 | $3,093,919 | $75,810 | $274,276 | $4,460,562 | $99,958 | $386,090 |
| Bedford Borough MA | PA0022209 | $0 | $0 | $0 | $2,860,429 | $61,420 | $244,909 | $4,188,471 | $95,308 | $363,986 |
| Bellefonte Borough | PA0020486 | $0 | $0 | $0 | $4,229,766 | $81,123 | $352,451 | $6,337,548 | $125,378 | $531,914 |
| Berwick MA | PA0023248 | $0 | $0 | $0 | $4,715,157 | $137,740 | $440,204 | $6,988,924 | $173,400 | $621,720 |
| Bloomsburg MA | PA0027171 | $0 | $0 | $0 | $4,935,313 | $110,171 | $426,757 | $7,456,126 | $171,969 | $650,258 |
| Blossburg | PA0020036 | $0 | $0 | $0 | $2,444,284 | $49,624 | $206,418 | $3,168,960 | $57,466 | $260,746 |
| Brown Township MA | PA0028088 | $0 | $0 | $0 | $2,444,284 | $49,450 | $206,244 | $3,168,960 | $61,882 | $265,161 |
| Burnham Borough | PA0038920 | $0 | $0 | $0 | $2,472,161 | $52,432 | $211,014 | $3,235,520 | $74,538 | $282,088 |
| Carlisle Borough | PA0026077 | $0 | $0 | $0 | $6,660,935 | $136,597 | $563,877 | $10,227,835 | $192,078 | $848,164 |
| Carlisle Suburban Authority | PA0024384 | $0 | $0 | $0 | $0 | $0 | $0 | $1,038,971 | $21,947 | $88,594 |
| Chambersburg Borough | PA0026051 | $6,400,000 | $124,868 | $535,409 | $6,623,722 | $194,641 | $619,534 | $6,623,722 | $220,445 | $645,338 |
| Clarks Summit-South Abington | PA0028576 | $0 | $0 | $0 | $3,583,756 | $107,432 | $337,319 | $5,220,606 | $171,843 | $506,730 |
| Clearfield | PA0026310 | $0 | $0 | $0 | $5,072,176 | $104,021 | $429,386 | $7,674,051 | $158,103 | $650,372 |
| Columbia | PA0026123 | $0 | $0 | $0 | $3,408,584 | $69,207 | $287,858 | $5,045,434 | $89,924 | $413,574 |
| Curwensville MA | PA0024759 | $0 | $0 | $0 | $2,374,508 | $51,188 | $203,506 | $3,002,478 | $68,728 | $261,329 |
| Danville MA | PA0023531 | $0 | $0 | $0 | $4,229,766 | $91,402 | $362,729 | $6,337,548 | $144,517 | $551,052 |
| Derry Twp. MA | PA0026484 | $0 | $0 | $0 | $1,983,000 | $120,430 | $247,634 | $3,223,000 | $165,702 | $372,448 |
| Dillsburg Borough | PA0024431 | $0 | $0 | $0 | $2,722,193 | $55,091 | $229,712 | $3,833,693 | $77,032 | $322,953 |
| Dover Twp. SA | PA0020826 | $0 | $0 | $0 | $0 | $11,171 | $11,171 | $2,408,870 | $98,381 | $252,903 |
| Duncansville | PA0032883 | $0 | $0 | $0 | $3,035,449 | $65,860 | $260,575 | $4,370,054 | $86,837 | $367,163 |
| East Pennsboro South WWTP | PA0038415 | $0 | $0 | $0 | $4,748,933 | $140,287 | $444,917 | $7,042,000 | $198,298 | $650,022 |
| Eastern Snyder County SA | PA0110582 | $3,000,000 | $61,856 | $254,297 | $3,187,310 | $104,746 | $309,203 | $3,187,310 | $113,409 | $317,866 |

## Exhibit E-37: Cumulative Point Source Facility Costs by Tier

| Facility | NPDES | Tier 1 Costs | | | Tier 2 Costs | | | Tier 3 Costs | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] |
| Elizabethtowne Borough | PA0023108 | $4,083,001 | $86,431 | $348,344 | $4,083,001 | $86,431 | $348,344 | $6,105,861 | $142,054 | $533,727 |
| Elkland MA | PA0113298 | $0 | $0 | $0 | $2,409,411 | $47,203 | $201,760 | $3,085,734 | $63,310 | $261,251 |
| Emporium Borough (Mid-Cameron) | PA0028631 | $0 | $0 | $0 | $2,503,139 | $56,125 | $216,694 | $3,150,451 | $74,822 | $276,914 |
| Ephrata Borough | PA0027405 | $0 | $0 | $0 | $4,613,914 | $105,209 | $401,178 | $6,945,582 | $171,283 | $616,822 |
| Fairview Twp. | PA0081868 | $0 | $0 | $0 | $2,374,508 | $47,883 | $200,201 | $3,002,478 | $62,016 | $254,617 |
| Franklin Co. Authority-Greencastle | PA0020834 | $0 | $0 | $0 | $2,304,611 | $46,741 | $194,575 | $2,835,875 | $87,706 | $269,619 |
| Gettysburg MA | PA0021563 | $0 | $0 | $0 | $0 | $0 | $0 | $1,494,026 | $40,756 | $136,594 |
| Greater Hazelton | PA0026921 | $0 | $0 | $0 | $7,840,000 | $163,170 | $666,083 | $24,090,000 | $586,537 | $2,131,842 |
| Gregg Twp. | PA0114821 | $0 | $0 | $0 | $0 | $1,822 | $1,822 | $918,088 | $25,596 | $84,489 |
| Hampden Twp. | PA0028746 | $0 | $0 | $0 | $0 | $641 | $641 | $1,544,208 | $38,981 | $138,037 |
| Hampden Twp. SA | PA0080314 | $0 | $0 | $0 | $3,747,289 | $73,618 | $313,996 | $5,577,144 | $120,181 | $477,938 |
| Hanover Borough | PA0026875 | $0 | $0 | $0 | $60,000 | $0 | $3,849 | $5,190,000 | $181,365 | $514,289 |
| Harrisburg SA | PA0027197 | $22,682,000 | $865,000 | $2,319,985 | $22,682,000 | $947,263 | $2,402,248 | $22,682,000 | $1,089,046 | $2,544,031 |
| Highspire | PA0024040 | $0 | $0 | $0 | $3,408,584 | $74,472 | $293,123 | $5,045,434 | $104,127 | $427,777 |
| Hollidaysburg Regional | PA0043273 | $0 | $0 | $0 | $3,408,584 | $84,480 | $303,130 | $5,045,434 | $168,669 | $492,319 |
| Houtzdale Borough Municipal | PA0046159 | $0 | $0 | $0 | $0 | $0 | $0 | $434,558 | $5,125 | $33,001 |
| Huntingdon Borough | PA0026191 | $0 | $0 | $0 | $4,580,956 | $99,010 | $392,865 | $6,893,324 | $149,919 | $592,106 |
| Hyndman Borough | PA0020851 | $0 | $0 | $0 | $2,097,017 | $42,091 | $176,609 | $2,342,031 | $48,261 | $198,495 |
| Jersey Shore Borough | PA0028665 | $0 | $0 | $0 | $2,724,589 | $85,654 | $260,428 | $3,642,677 | $111,308 | $344,976 |
| Kelly Twp. MA | PA0028681 | $0 | $0 | $0 | $0 | $0 | $0 | $1,926,358 | $42,475 | $166,045 |
| Lackawanna River Basin SA | PA0027090 | $0 | $0 | $0 | $6,660,935 | $128,655 | $555,935 | $13,580,935 | $309,619 | $1,180,797 |
| Lackawanna River Basin SA | PA0027065 | $0 | $0 | $0 | $6,034,411 | $133,365 | $520,455 | $9,215,301 | $187,093 | $778,228 |
| Lackawanna River Basin SA | PA0027073 | $0 | $0 | $0 | $2,722,193 | $55,025 | $229,646 | $3,833,693 | $66,364 | $312,285 |
| Lackawanna River Basin SA | PA0027081 | $2,513,941 | $55,025 | $216,287 | $2,513,941 | $55,521 | $216,784 | $3,335,323 | $73,517 | $287,468 |
| Lancaster Area SA | PA0042269 | $4,249,333 | $93,253 | $365,835 | $4,249,333 | $93,253 | $365,835 | $14,709,333 | $293,204 | $1,236,766 |
| Lancaster City | PA0026743 | $1,077,000 | $8,461 | $77,547 | $1,077,000 | $8,461 | $77,547 | $24,157,000 | $620,831 | $2,170,434 |
| Lebanon City Authority | PA0027316 | $0 | $0 | $0 | $4,039,000 | $139,109 | $398,199 | $11,659,000 | $336,057 | $1,083,948 |
| Lemoyne Borough MA | PA0026441 | $0 | $0 | $0 | $3,468,413 | $77,654 | $300,143 | $5,139,232 | $123,963 | $453,630 |
| Lewisburg Area JSA | PA0044661 | $3,693,297 | $75,717 | $312,631 | $3,693,297 | $78,960 | $315,874 | $7,323,297 | $136,768 | $606,537 |
| Lewistown Borough | PA0026280 | $0 | $0 | $0 | $3,679,787 | $80,393 | $316,441 | $5,471,041 | $131,005 | $481,957 |

## Exhibit E-37: Cumulative Point Source Facility Costs by Tier

| Facility | NPDES | Tier 1 Costs | | | Tier 2 Costs | | | Tier 3 Costs | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] |
| Lititz SA | PA0020320 | $0 | $0 | $0 | $4,415,719 | $94,250 | $377,506 | $6,631,584 | $167,511 | $592,908 |
| Littlestown Borough | PA0021229 | $0 | $0 | $0 | $2,722,193 | $57,995 | $232,616 | $3,833,693 | $75,566 | $321,486 |
| Lock Haven | PA0025933 | $4,580,956 | $94,176 | $388,031 | $4,782,679 | $123,736 | $430,531 | $9,372,679 | $215,398 | $816,628 |
| Logan Twp. - Greenwood | PA0032557 | $2,444,284 | $49,316 | $206,110 | $2,566,507 | $56,881 | $221,515 | $3,291,183 | $70,668 | $281,788 |
| Lower Allen Twp. Authority | PA0027189 | $0 | $0 | $0 | $6,002,771 | $136,328 | $521,389 | $9,164,360 | $211,154 | $799,021 |
| Lower Lackawanna Valley | PA0026361 | $0 | $0 | $0 | $6,034,411 | $141,695 | $528,785 | $9,215,301 | $218,538 | $809,673 |
| Lykens Borough | PA0043575 | $0 | $0 | $0 | $2,311,606 | $47,089 | $195,372 | $2,852,541 | $57,051 | $240,033 |
| Manhanoy City | PA0070041 | $0 | $0 | $0 | $165,765 | $11,192 | $21,825 | $1,563,289 | $29,810 | $130,091 |
| Manheim Borough Authority | PA0020893 | $0 | $0 | $0 | $2,722,193 | $57,468 | $232,089 | $3,833,693 | $84,969 | $330,889 |
| Mansfield Borough | PA0021814 | $0 | $0 | $0 | $2,882,193 | $64,115 | $248,999 | $3,993,693 | $84,049 | $340,233 |
| Marietta-Donegal Authority | PA0021717 | $0 | $0 | $0 | $2,444,284 | $49,379 | $206,172 | $3,168,960 | $66,373 | $269,653 |
| Martinsburg | PA0028347 | $0 | $0 | $0 | $2,374,508 | $49,549 | $201,867 | $3,002,478 | $65,572 | $258,172 |
| Marysville MA | PA0021571 | $0 | $0 | $0 | $2,374,508 | $48,576 | $200,894 | $3,002,478 | $85,887 | $278,488 |
| Mechanicsburg Borough Municipal | PA0020885 | $0 | $0 | $0 | $3,462,978 | $67,602 | $289,743 | $5,130,708 | $90,753 | $419,874 |
| Middletown | PA0020664 | $0 | $0 | $0 | $3,544,425 | $72,505 | $299,870 | $5,258,477 | $101,333 | $438,649 |
| Mifflinburg Borough Authority | PA0028461 | $0 | $0 | $0 | $0 | $0 | $0 | $639,575 | $25,758 | $66,785 |
| Millersburg Borough Authority | PA0022535 | $0 | $0 | $0 | $2,722,193 | $56,923 | $231,544 | $3,833,693 | $81,131 | $327,051 |
| Millersville Borough | PA0026620 | $0 | $0 | $0 | $2,722,193 | $56,514 | $231,135 | $3,833,693 | $80,385 | $326,305 |
| Milton MA | PA0020273 | $0 | $0 | $0 | $3,814,671 | $76,696 | $321,396 | $5,683,127 | $112,144 | $476,700 |
| Montgomery Borough | PA0020699 | $0 | $0 | $0 | $2,566,507 | $57,984 | $222,618 | $3,291,183 | $77,453 | $288,573 |
| Moshannon Valley JSA | PA0037966 | $0 | $0 | $0 | $3,066,885 | $62,920 | $259,652 | $4,510,730 | $100,067 | $389,418 |
| Mounty Joy | PA0021067 | $0 | $0 | $0 | $2,929,367 | $56,610 | $244,521 | $4,296,010 | $77,537 | $353,114 |
| Mount Union Borough | PA0020214 | $0 | $0 | $0 | $2,465,194 | $50,502 | $208,638 | $3,218,882 | $63,113 | $269,595 |
| Mountaintop Area | PA0045985 | $0 | $0 | $0 | $181,241 | $64,537 | $76,163 | $1,972,495 | $137,919 | $264,449 |
| Mt. Carmel MSA | PA0024406 | $0 | $0 | $0 | $3,234,471 | $79,778 | $287,260 | $4,678,316 | $109,540 | $409,641 |
| Mt. Holly Springs Borough Authority | PA0023183 | $0 | $0 | $0 | $2,444,284 | $48,311 | $205,104 | $3,168,960 | $61,362 | $264,641 |
| Muncy Borough MA | PA0024325 | $0 | $0 | $0 | $2,998,186 | $62,575 | $254,900 | $4,403,430 | $83,305 | $365,772 |
| New Cumberland Borough MA | PA0026654 | $0 | $0 | $0 | $2,894,913 | $58,383 | $244,083 | $4,242,256 | $72,483 | $344,611 |
| New Freedom WWTP | PA0043257 | $0 | $0 | $0 | $2,929,367 | $61,546 | $249,456 | $4,296,010 | $99,960 | $375,537 |
| New Holland Borough | PA0021890 | $0 | $0 | $0 | $2,819,009 | $58,751 | $239,582 | $4,123,890 | $97,876 | $362,411 |

## Exhibit E-37: Cumulative Point Source Facility Costs by Tier

| Facility | NPDES | Tier 1 Costs | | | Tier 2 Costs | | | Tier 3 Costs | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] |
| New Oxford Municipal Facility | PA0020923 | $0 | $0 | $0 | $0 | $0 | $0 | $942,264 | $37,444 | $97,888 |
| Newberry Twp. | PA0083011 | $0 | $0 | $0 | $2,304,611 | $48,327 | $196,161 | $2,835,875 | $65,488 | $247,402 |
| Northeastern York Country | PA0023744 | $0 | $0 | $0 | $3,203,924 | $66,014 | $271,537 | $4,724,971 | $85,380 | $388,473 |
| Northumberland Borough | PA0020567 | $0 | $0 | $0 | $2,548,725 | $51,570 | $215,063 | $3,418,460 | $66,052 | $285,336 |
| Palmyra Borough Authority | PA0024287 | $0 | $0 | $0 | $3,011,935 | $60,600 | $253,807 | $4,424,900 | $86,841 | $370,685 |
| Penn Twp. | PA0037150 | $0 | $0 | $0 | $4,876,496 | $97,677 | $410,490 | $7,362,568 | $136,468 | $608,755 |
| Pine Creek MA | PA0027553 | $0 | $0 | $0 | $2,929,367 | $62,319 | $250,230 | $4,296,010 | $83,751 | $359,328 |
| Pine Grove Borough Authority | PA0020915 | $0 | $0 | $0 | $2,566,507 | $58,279 | $222,914 | $3,291,183 | $75,241 | $286,361 |
| Porter Tower Joint MA | PA0046272 | $0 | $0 | $0 | $0 | $1,395 | $1,395 | $560,276 | $24,286 | $60,226 |
| Roaring Spring Borough | PA0020249 | $0 | $0 | $0 | $0 | $3,041 | $3,041 | $821,382 | $27,964 | $80,653 |
| Sayre | PA0043681 | $0 | $0 | $0 | $3,367,738 | $68,131 | $284,162 | $4,981,427 | $83,309 | $402,854 |
| Scranton SA | PA0026492 | $0 | $0 | $0 | $0 | $85,177 | $85,177 | $11,673,110 | $341,203 | $1,089,999 |
| Shamokin-Coal Twp. JSA | PA0027324 | $0 | $0 | $0 | $6,660,935 | $163,547 | $590,827 | $10,227,835 | $240,030 | $896,117 |
| Shenandoah MSA | PA0070386 | $0 | $0 | $0 | $3,408,584 | $69,167 | $287,818 | $5,045,434 | $96,397 | $420,047 |
| Shippensburg Borough Authority | PA0030643 | $0 | $0 | $0 | $3,915,519 | $80,883 | $332,053 | $5,841,877 | $127,231 | $501,970 |
| Silver Spring Twp. | PA0083593 | $0 | $0 | $0 | $2,374,508 | $47,610 | $199,928 | $3,002,478 | $52,918 | $245,519 |
| South Middleton Twp. MA | PA0044113 | $0 | $0 | $0 | $2,548,725 | $51,419 | $214,912 | $3,418,460 | $65,314 | $284,599 |
| Springettsbury Twp. | PA0026808 | $0 | $0 | $0 | $0 | $29,686 | $29,686 | $6,654,980 | $256,095 | $682,993 |
| St. Johns | PA0046388 | $0 | $0 | $0 | $0 | $185 | $185 | $724,676 | $12,242 | $58,727 |
| Stewartstown Borough | PA0036269 | $0 | $0 | $0 | $2,304,611 | $47,231 | $195,066 | $2,835,875 | $58,511 | $240,424 |
| Sunbury City MA | PA0026557 | $3,000,000 | $63,044 | $255,485 | $3,197,930 | $102,080 | $307,218 | $5,697,930 | $182,367 | $547,873 |
| Swatara Twp. | PA0026735 | $2,000,000 | $32,982 | $161,276 | $2,000,000 | $50,767 | $179,062 | $7,659,000 | $123,800 | $615,103 |
| Towanda MA | PA0034576 | $0 | $0 | $0 | $160,000 | $9,298 | $19,562 | $1,271,500 | $32,968 | $114,531 |
| Tri-Boro MA | PA0023736 | $0 | $0 | $0 | $2,374,508 | $47,736 | $200,054 | $3,002,478 | $58,834 | $251,434 |
| Twin Boroughs SA | PA0023264 | $0 | $0 | $0 | $2,444,284 | $50,110 | $206,903 | $3,168,960 | $63,114 | $266,393 |
| Tyrone Borough SA | PA0026727 | $0 | $0 | $0 | $0 | $0 | $0 | $4,338,920 | $99,159 | $377,488 |
| University Area JSA | PA0026239 | $780,000 | $6,986 | $57,021 | $780,000 | $6,986 | $57,021 | $1,300,000 | $27,584 | $110,975 |
| Upper Allen Twp. | PA0024902 | $0 | $0 | $0 | $2,360,538 | $50,070 | $201,492 | $2,969,167 | $72,010 | $262,474 |
| Washington Twp. Municipal | PA0080225 | $0 | $0 | $0 | $160,000 | $15,254 | $25,518 | $1,271,500 | $47,511 | $129,074 |
| Waynesboro Borough | PA0020621 | $0 | $0 | $0 | $3,297,563 | $120,030 | $331,559 | $4,776,149 | $151,312 | $457,689 |

## Exhibit E-37: Cumulative Point Source Facility Costs by Tier

| Facility | NPDES | Tier 1 Costs | | | Tier 2 Costs | | | Tier 3 Costs | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] |
| Wellsboro MA | PA0021687 | $0 | $0 | $0 | $3,408,584 | $73,375 | $292,026 | $5,045,434 | $106,804 | $430,455 |
| Western Clinton County MA | PA0043893 | $0 | $0 | $0 | $0 | $0 | $0 | $1,014,794 | $12,018 | $77,114 |
| White Deer Twp. | PA0020800 | $0 | $0 | $0 | $2,423,823 | $52,083 | $207,564 | $2,974,428 | $63,250 | $254,051 |
| Williamsport SA - Central | PA0027057 | $6,330,000 | $137,056 | $543,107 | $6,634,134 | $288,286 | $713,846 | $16,244,134 | $545,016 | $1,587,030 |
| Williamsport SA - West | PA0027049 | $5,246,000 | $112,263 | $448,779 | $5,459,102 | $184,866 | $535,052 | $15,219,102 | $375,425 | $1,351,686 |
| Wyoming Valley | PA0026107 | $0 | $0 | $0 | $0 | $71,004 | $71,004 | $24,690,000 | $601,947 | $2,185,739 |
| York City | PA0026263 | $0 | $0 | $0 | $0 | $0 | $0 | $11,080,000 | $171,126 | $881,876 |
| **PA Subtotal** | | **$72,079,813** | **$1,866,433** | **$6,490,146** | **$354,738,565** | **$9,258,800** | **$32,014,260** | **$674,549,971** | **$16,994,450** | **$60,264,894** |
| Alexandria | VA0025160 | $0 | $0 | $0 | $0 | $0 | $0 | $20,000,000 | $592,000 | $2,050,633 |
| Alleghany Co Lower Jackson | VA0090671 | $0 | $0 | $0 | $3,234,471 | $126,119 | $362,014 | $4,678,316 | $149,719 | $490,917 |
| Aquia | VA0060968 | $8,000,000 | $160,000 | $743,453 | $8,000,000 | $160,000 | $743,453 | $12,000,000 | $195,000 | $1,070,180 |
| Arlington | VA0025143 | $0 | $0 | $0 | $0 | $0 | $0 | $16,305,230 | $489,067 | $1,678,235 |
| Ashland | VA0024899 | $2,415,700 | $45,093 | $221,274 | $2,590,872 | $67,818 | $256,774 | $2,590,872 | $76,193 | $265,150 |
| Broad Run WRF | VA_BROADR | $13,500,000 | $268,466 | $1,253,044 | $13,500,000 | $268,466 | $1,253,044 | $20,154,980 | $303,629 | $1,773,565 |
| Buena Vista | VA0020991 | $0 | $0 | $0 | $3,757,275 | $90,102 | $364,127 | $5,490,628 | $129,571 | $530,012 |
| Cape Charles | VA0021288 | $0 | $0 | $0 | $2,288,710 | $48,501 | $215,420 | $2,674,915 | $55,864 | $250,950 |
| Caroline County Regional | VA0073504 | $0 | $0 | $0 | $2,487,286 | $55,063 | $236,464 | $3,115,256 | $62,753 | $289,954 |
| Clifton Forge | VA0022772 | $0 | $0 | $0 | $3,583,756 | $85,609 | $346,979 | $5,220,606 | $120,531 | $501,278 |
| Colonial Beach | VA0026409 | $90,000 | $740 | $7,304 | $265,172 | $16,310 | $35,650 | $3,625,172 | $60,648 | $325,038 |
| Covington | VA0025542 | $0 | $0 | $0 | $4,273,345 | $130,890 | $442,552 | $6,296,205 | $175,535 | $634,727 |
| Crewe STP | VA0020303 | $0 | $0 | $0 | $2,374,508 | $47,295 | $220,472 | $3,002,478 | $53,949 | $272,925 |
| Culpepper | VA0061590 | $4,200,000 | $82,381 | $388,694 | $4,200,000 | $93,433 | $399,746 | $6,801,875 | $145,678 | $641,750 |
| Dahlgren SA | VA0026514 | $0 | $0 | $0 | $30,000 | $0 | $2,188 | $550,000 | $13,469 | $53,582 |
| Dale City #1 | VA0024724 | $0 | $0 | $0 | $0 | $0 | $0 | $1,060,000 | $24,433 | $101,741 |
| Dale City #8 | VA0024678 | $0 | $0 | $0 | $0 | $0 | $0 | $1,060,000 | $22,724 | $100,032 |
| Doswell | VA0029521 | $3,045,000 | $57,875 | $279,952 | $3,205,000 | $143,615 | $377,361 | $3,205,000 | $149,018 | $382,764 |
| Falling Creek | VA0024996 | $395,818 | $2,206 | $31,074 | $395,818 | $19,918 | $48,786 | $5,993,818 | $457,439 | $894,578 |
| Farmville | VA0083135 | $0 | $0 | $0 | $181,241 | $19,315 | $32,533 | $1,972,495 | $45,297 | $189,154 |
| Fishersville | VA0025291 | $0 | $0 | $0 | $965,172 | $41,569 | $111,960 | $4,325,172 | $131,168 | $446,610 |
| FMC | VA0068110 | $0 | $0 | $0 | $0 | $13,603 | $13,603 | $2,949,284 | $87,018 | $302,115 |

## Exhibit E-37: Cumulative Point Source Facility Costs by Tier

| Facility | NPDES | Tier 1 Costs | | | Tier 2 Costs | | | Tier 3 Costs | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] |
| Fort A.P. Hill | VA0032034 | $0 | $0 | $0 | $115,611 | $5,259 | $13,691 | $772,593 | $9,771 | $66,118 |
| Fredericksburg | VA0025127 | $0 | $0 | $0 | $0 | $5,819 | $5,819 | $2,215,865 | $59,822 | $221,429 |
| Front Royal | VA0062812 | $0 | $0 | $0 | $50,000 | $2,469 | $6,116 | $4,840,000 | $117,049 | $470,038 |
| FWSA Opequan | VA0065552 | $0 | $0 | $0 | $0 | $6,903 | $6,903 | $6,390,000 | $276,733 | $742,766 |
| Gordonsville | VA0021105 | $0 | $0 | $0 | $2,621,890 | $58,281 | $249,500 | $3,414,260 | $79,155 | $328,163 |
| H.L. Mooney | VA0025101 | $0 | $0 | $0 | $0 | $0 | $0 | $8,011,100 | $267,500 | $851,763 |
| Harrisonburg-Rockingham Regional | VA0060640 | $0 | $0 | $0 | $387,580 | $123,328 | $151,595 | $7,428,570 | $356,040 | $897,818 |
| Haymount STP | VA0089125 | $2,687,559 | $53,319 | $249,327 | $2,687,559 | $57,246 | $253,254 | $3,750,706 | $90,365 | $363,910 |
| Henrico County | VA0063690 | $0 | $0 | $0 | $300,000 | $500,000 | $521,879 | $25,300,000 | $4,770,175 | $6,615,346 |
| Hopewell | VA0066630 | $0 | $0 | $0 | $58,300,000 | $2,748,200 | $7,000,116 | $71,500,000 | $4,351,500 | $9,566,114 |
| HRSD-Army Base | VA0081230 | $0 | $0 | $0 | $81,000,000 | $209,819 | $6,117,284 | $88,813,010 | $556,083 | $7,033,363 |
| HRSD-Boat Harbor | VA0081256 | $0 | $0 | $0 | $112,000,000 | $229,125 | $8,397,471 | $122,515,080 | $679,691 | $9,614,920 |
| HRSD-Chesapeake/Elizabeth | VA0081264 | $0 | $0 | $0 | $35,000,000 | $338,604 | $2,891,212 | $45,129,070 | $853,532 | $4,144,871 |
| HRSD-James River | VA0081272 | $0 | $0 | $0 | $27,300,000 | $184,767 | $2,175,802 | $35,885,030 | $579,518 | $3,196,673 |
| HRSD-Namsemond | VA0081299 | $0 | $0 | $0 | $13,100,000 | $43,772 | $999,177 | $25,545,130 | $440,573 | $2,303,622 |
| HRSD-VIP | VA0081281 | $0 | $0 | $0 | $10,000,000 | $0 | $729,317 | $26,305,230 | $687,846 | $2,606,330 |
| HRSD-Williamsburg | VA0081302 | $0 | $0 | $0 | $15,800,000 | $0 | $1,152,320 | $25,350,055 | $312,147 | $2,160,968 |
| HRSD-York | VA0081311 | $17,700,000 | $132,100 | $1,422,990 | $17,700,000 | $166,896 | $1,457,787 | $24,354,980 | $422,229 | $2,198,479 |
| Kilmarnock | VA0020788 | $0 | $0 | $0 | $2,248,904 | $65,962 | $229,978 | $2,586,756 | $79,166 | $267,822 |
| Lake Monticello STP | VA0024945 | $0 | $0 | $0 | $2,566,507 | $57,176 | $244,355 | $3,291,183 | $78,511 | $318,542 |
| Leesburg | MD0066184 | $0 | $0 | $0 | $0 | $10,322 | $10,322 | $2,736,978 | $77,501 | $277,114 |
| Lexington-Rockbridge Regional | VA0088161 | $0 | $0 | $0 | $205,516 | $14,863 | $29,851 | $2,614,386 | $35,274 | $225,946 |
| Little Falls Run | VA0076392 | $0 | $0 | $0 | $0 | $0 | $0 | $4,000,000 | $37,207 | $328,934 |
| Luray | VA0062642 | $0 | $0 | $0 | $0 | $0 | $0 | $3,360,000 | $86,100 | $331,150 |
| Lynchburg | VA0024970 | $0 | $0 | $0 | $54,478,612 | $928,781 | $4,901,997 | $55,323,612 | $2,022,802 | $6,057,645 |
| Massanutten Public Service STP | VA0024732 | $0 | $0 | $0 | $2,685,114 | $57,618 | $253,448 | $3,554,849 | $71,330 | $330,591 |
| Massaponax | VA0025658 | $0 | $0 | $0 | $0 | $0 | $0 | $3,952,910 | $92,755 | $381,047 |
| Mathews Courthouse | VA0028819 | $0 | $0 | $0 | $2,094,204 | $42,093 | $194,827 | $2,335,350 | $48,162 | $218,483 |
| Middle River | VA0064793 | $0 | $0 | $0 | $247,998 | $54,207 | $72,294 | $3,737,696 | $176,155 | $448,751 |
| Montross-Westmoreland | VA0072729 | $0 | $0 | $0 | $2,094,204 | $41,914 | $194,648 | $2,335,350 | $44,268 | $214,589 |

## Exhibit E-37: Cumulative Point Source Facility Costs by Tier

| Facility | NPDES | Tier 1 Costs | | | Tier 2 Costs | | | Tier 3 Costs | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] |
| Moores Creek-Rivanna Authority | VA0025518 | $0 | $0 | $0 | $11,614,484 | $428,783 | $1,275,847 | $18,269,464 | $666,666 | $1,999,089 |
| Navel Surface Warfare Center | VA0021067 | $0 | $0 | $0 | $103,334 | $50,513 | $58,049 | $634,598 | $68,518 | $114,801 |
| New Market STP | VA0022853 | $0 | $0 | $0 | $2,487,286 | $55,524 | $236,926 | $3,115,256 | $77,469 | $304,670 |
| Noman M. Cole PCP | VA0025364 | $0 | $0 | $0 | $0 | $0 | $0 | $12,760,000 | $345,810 | $1,276,418 |
| Onanock | VA0021253 | $0 | $0 | $0 | $2,288,710 | $53,538 | $220,458 | $2,674,915 | $64,858 | $259,944 |
| Orange | VA0021385 | $3,066,885 | $59,901 | $283,574 | $3,234,471 | $71,827 | $307,723 | $4,678,316 | $93,586 | $434,783 |
| Parham Landing WWTP | VA0088331 | $0 | $0 | $0 | $2,423,364 | $48,416 | $225,156 | $3,119,028 | $52,112 | $279,588 |
| Parkins Mill | VA0075191 | $0 | $0 | $0 | $272,172 | $22,047 | $41,897 | $3,632,172 | $96,504 | $361,404 |
| Proctors Creek | VA0060194 | $0 | $0 | $0 | $0 | $0 | $0 | $1,500,000 | $526,000 | $635,397 |
| Purcellville | VA0022802 | $0 | $0 | $0 | $160,000 | $8,452 | $20,121 | $1,271,500 | $16,531 | $109,263 |
| Quanitico-Mainside | VA0028363 | $0 | $0 | $0 | $0 | $0 | $0 | $1,714,052 | $30,504 | $155,513 |
| Reedville | VA0060712 | $0 | $0 | $0 | $2,248,904 | $46,528 | $210,544 | $2,586,756 | $48,551 | $237,207 |
| Remington Regional | VA0076805 | $0 | $0 | $0 | $175,172 | $8,744 | $21,519 | $1,812,022 | $24,964 | $157,118 |
| Richmond | VA0063177 | $70,000,000 | $1,350,323 | $6,455,540 | $70,000,000 | $1,548,696 | $6,653,912 | $80,000,000 | $2,057,412 | $7,891,946 |
| Round Hill WWTP | VA0026212 | $0 | $0 | $0 | $2,487,286 | $51,922 | $233,324 | $3,115,256 | $57,823 | $285,024 |
| Sil MRRS | VA0090263 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| South Central | VA0025437 | $7,800,000 | $338,000 | $906,867 | $7,800,000 | $391,448 | $960,315 | $12,100,000 | $708,448 | $1,590,921 |
| South Wales STP | VA0080527 | $2,622,367 | $52,058 | $243,311 | $2,622,367 | $55,596 | $246,849 | $3,594,610 | $85,891 | $348,052 |
| Stony Creek | VA0028380 | $0 | $0 | $0 | $2,566,507 | $54,061 | $241,241 | $3,291,183 | $64,029 | $304,060 |
| Strasburg | VA0020311 | $0 | $0 | $0 | $278,111 | $13,538 | $33,821 | $2,928,111 | $72,663 | $286,215 |
| Stuarts Draft | VA0066877 | $0 | $0 | $0 | $0 | $11,513 | $11,513 | $520,000 | $34,588 | $72,513 |
| Tangier Island | VA0067423 | $0 | $0 | $0 | $2,169,205 | $45,611 | $203,814 | $2,410,351 | $49,119 | $224,910 |
| Tappahannock | VA0071471 | $0 | $0 | $0 | $2,407,945 | $52,018 | $227,634 | $2,939,209 | $67,531 | $281,892 |
| Totopotomoy | VA0089915 | $0 | $0 | $0 | $0 | $20,668 | $20,668 | $2,794,880 | $133,621 | $337,456 |
| Upper Occoquan SA | VA0024988 | $0 | $0 | $0 | $22,601,459 | $394,910 | $2,043,272 | $44,310,829 | $861,908 | $4,093,571 |
| Urbanna | VA0026263 | $0 | $0 | $0 | $2,169,205 | $50,577 | $208,781 | $2,410,351 | $59,150 | $234,940 |
| Warrenton | VA0021172 | $0 | $0 | $0 | $3,747,289 | $74,015 | $347,311 | $5,577,144 | $105,163 | $511,913 |
| Warsaw | VA0026891 | $0 | $0 | $0 | $2,328,485 | $62,036 | $231,857 | $2,763,043 | $71,873 | $273,386 |
| Waynesboro | VA0025151 | $0 | $0 | $0 | $3,705,516 | $127,144 | $397,394 | $3,705,516 | $142,355 | $412,604 |
| West Point | VA0075434 | $0 | $0 | $0 | $2,566,507 | $58,492 | $245,672 | $3,291,183 | $81,605 | $321,636 |

## Exhibit E-37: Cumulative Point Source Facility Costs by Tier

| Facility | NPDES | Tier 1 Costs | | | Tier 2 Costs | | | Tier 3 Costs | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] |
| Weyers Cave STP | VA0022349 | $0 | $0 | $0 | $2,487,286 | $54,453 | $235,855 | $3,115,256 | $70,135 | $297,336 |
| Widewater WWTP | VA0090387 | $2,374,508 | $47,445 | $220,621 | $2,487,286 | $50,527 | $231,929 | $3,115,256 | $54,447 | $281,648 |
| Wilderness Shores | VA0083411 | $0 | $0 | $0 | $2,487,286 | $58,383 | $239,785 | $3,115,256 | $79,802 | $307,003 |
| Woodstock | VA0026468 | $0 | $0 | $0 | $841,111 | $21,141 | $82,485 | $3,491,111 | $60,069 | $314,682 |
| **VA Subtotal** | | **$137,897,837** | **$2,649,908** | **$12,707,027** | **$659,077,069** | **$11,372,172** | **$59,439,761** | **$996,778,672** | **$28,329,372** | **$101,026,102** |
| Berkeley County PSSD | WV0082759 | $0 | $0 | $0 | $3,826,474 | $91,831 | $297,527 | $5,598,427 | $116,742 | $417,692 |
| Berkeley County PSSD | WV0020061 | $0 | $0 | $0 | $2,803,451 | $65,993 | $216,696 | $3,818,245 | $87,127 | $292,381 |
| Charlestown | WV0022349 | $0 | $0 | $0 | $3,023,464 | $72,361 | $234,891 | $4,351,506 | $98,245 | $332,165 |
| Keyer | WV0024392 | $0 | $0 | $0 | $3,679,787 | $75,198 | $273,009 | $5,471,041 | $107,430 | $401,532 |
| Martinsburg | WV0023167 | $0 | $0 | $0 | $5,616,603 | $91,103 | $393,030 | $8,411,483 | $144,112 | $596,281 |
| Moorefield | WV0020150 | $0 | $0 | $0 | $122,222 | $3,779 | $10,349 | $846,898 | $4,319 | $49,845 |
| Petersburg | WV0021792 | $0 | $0 | $0 | $2,724,589 | $66,531 | $212,994 | $3,642,677 | $92,850 | $288,666 |
| Romeny | WV0020699 | $0 | $0 | $0 | $2,487,286 | $56,451 | $190,158 | $3,115,256 | $74,353 | $241,817 |
| **WV Subtotal** | | **$0** | **$0** | **$0** | **$24,283,876** | **$523,247** | **$1,828,655** | **$35,255,533** | **$725,177** | **$2,620,379** |
| **Municipal Total** | | **$597,914,959** | **$12,368,080** | **$51,212,168** | **$1,559,443,956** | **$41,097,699** | **$145,783,698** | **$2,749,938,705** | **$87,442,787** | **$270,364,000** |
| **Industrial Facilities** | | | | | | | | | | |
| Dupont Seaford | DE0000035 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **DE Subtotal** | | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** |
| Allen Family Foods | MD0067857 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Bethlehem Steel Corp-Sparrows Pt. | MD0001201 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Chemetals | MD0001775 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Congoleum | MD0001384 | $0 | $0 | $0 | $0 | $0 | $0 | $398,764 | $11,061 | $45,153 |
| Garden State Tanning | MD0053431 | $0 | $0 | $0 | $5,000,000 | $400,000 | $827,468 | $10,000,000 | $800,000 | $1,654,936 |
| MD & VA Milk Producers | MD0000469 | $0 | $0 | $0 | $7,350,911 | $181,548 | $810,004 | $7,840,242 | $196,844 | $867,134 |
| NSWC-Indian Head | MD0003158 | $0 | $0 | $0 | $111,434 | $10,261 | $19,788 | $111,434 | $12,886 | $22,412 |
| Upper Potomac River Commission | MD0021687 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $109,197 | $109,197 |
| WR Grace | MD0000311 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Westavco Corp-Luke | MD0001422 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **MD Subtotal** | | **$0** | **$0** | **$0** | **$12,462,345** | **$591,809** | **$1,657,260** | **$18,350,440** | **$1,129,987** | **$2,698,833** |
| Appleton Paper Springmill | PA0008265 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $23,341 | $23,341 |

## Exhibit E-37: Cumulative Point Source Facility Costs by Tier

| Facility | NPDES | Tier 1 Costs | | | Tier 2 Costs | | | Tier 3 Costs | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] |
| Chloe Textiles Inc. | PA0009172 | $0 | $0 | $0 | $0 | $0 | $0 | $406,239 | $12,159 | $46,890 |
| Consolidated Rail Corp-Enola | PA0009229 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Empire Kosher Poultry-Mifflint | PA0007552 | $0 | $0 | $0 | $0 | $0 | $0 | $1,315,629 | $33,331 | $145,808 |
| Gold Mills Dyehouse | PA0008231 | $0 | $0 | $0 | $0 | $0 | $0 | $805,777 | $21,430 | $90,319 |
| Heinz Pet Foods | PA0009270 | $0 | $0 | $0 | $4,166,532 | $126,991 | $483,203 | $4,812,532 | $147,153 | $558,594 |
| Merck & Co. | PA0008419 | $0 | $0 | $0 | $337,450 | $58,179 | $87,029 | $337,450 | $126,782 | $155,631 |
| National Gypsum Co.-Milton Plant | PA0008591 | $0 | $0 | $0 | $0 | $718 | $718 | $0 | $2,393 | $2,393 |
| Osram Sylvania Products Inc. | PA0009024 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $5,863 | $5,863 |
| P-H Glatfelter Company | PA0008869 | $0 | $0 | $0 | $4,905,080 | $86,637 | $505,990 | $10,576,472 | $256,021 | $1,160,242 |
| PA Fish & Boat-Belofonte | PA0040835 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| PA Fish & Boat-Benner Springs | PA0010553 | $0 | $0 | $0 | $0 | $0 | $0 | $3,180,697 | $102,575 | $374,505 |
| PA Fish & Boat-Pleasant Gap | PA0010561 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| PA Fish & Boat-Typersville | PA0112127 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| PA Fish & Boat-Upper Spring | PA0044032 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Pope and Talbot Wis Inc. | PA0007919 | $0 | $0 | $0 | $0 | $0 | $0 | $1,502,717 | $51,235 | $179,708 |
| Proctor & Gamble Paper Products | PA0008885 | $0 | $0 | $0 | $4,674,320 | $142,312 | $541,937 | $7,424,503 | $257,765 | $892,513 |
| Tyson Foods | PA0035092 | $0 | $0 | $0 | $4,039,977 | $79,131 | $424,523 | $4,716,300 | $97,263 | $500,476 |
| USFW-Lamar Fish Hatchery | PA0009857 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **PA Subtotal** | | **$0** | **$0** | **$0** | **$18,123,358** | **$493,968** | **$2,043,399** | **$35,078,315** | **$1,137,311** | **$4,136,284** |
| Amoco-Yorktown | VA0003018 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Brown & Williamson | VA0002780 | $0 | $0 | $0 | $0 | $5,173 | $5,173 | $942,156 | $34,534 | $115,083 |
| BWXT | VA0003697 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $2,588 | $2,588 |
| Dupont-Spruance | VA0004669 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Dupont-Waynesboro | VA0002160 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Georgia Pacific Corp. | VA0003026 | $0 | $0 | $0 | $254,176 | $386,421 | $408,151 | $254,176 | $425,365 | $447,095 |
| George's Chicken | VA0077402 | $0 | $0 | $0 | $3,848,000 | $0 | $328,979 | $3,848,000 | $0 | $328,979 |
| Honeywell | VA0005291 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Less Commercial Carpet | VA0004677 | $0 | $0 | $0 | $2,000,000 | $0 | $170,987 | $2,000,000 | $0 | $170,987 |
| Merck & Co.-Stonewall Plant | VA0002178 | $0 | $0 | $0 | $0 | $0 | $0 | $800,000 | $54,503 | $122,898 |
| Phillip Morris-Park 500 | VA0026557 | $0 | $0 | $0 | $3,500,000 | $1,300,000 | $1,599,228 | $11,500,000 | $3,200,000 | $4,183,177 |

## Exhibit E-37: Cumulative Point Source Facility Costs by Tier

| Facility | NPDES | Tier 1 Costs | | | Tier 2 Costs | | | Tier 3 Costs | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] | Capital | O&M | Annual Costs[1] |
| Pilgrims Pride-Hinton | VA0002313 | $0 | $0 | $0 | $5,442,689 | $247,682 | $712,998 | $6,109,177 | $268,481 | $790,776 |
| Smurfit Stone | VA0003115 | $0 | $0 | $0 | $0 | $35,786 | $35,786 | $0 | $135,464 | $135,464 |
| Tysons Foods, Inc. | VA0004031 | $0 | $0 | $0 | $0 | $0 | $0 | $150,000 | $1,200 | $14,024 |
| Tysons Foods, Inc-Temerpanceville | VA0004049 | $0 | $0 | $0 | $6,500 | $150,000 | $150,556 | $631,500 | $195,625 | $249,614 |
| Westavco-Covington Hall | VA0003646 | $0 | $0 | $0 | $0 | $0 | $0 | $12,340,085 | $307,945 | $1,362,943 |
| **VA Subtotal** | | **$0** | **$0** | **$0** | **$15,051,365** | **$2,125,063** | **$3,411,858** | **$38,575,094** | **$4,625,704** | **$7,923,629** |
| Hester Industries | WV0047236 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Specratech International | WV0005533 | $0 | $0 | $0 | $5,286,279 | $107,156 | $559,099 | $5,736,257 | $121,229 | $611,642 |
| Wampler-Longacre Inc. | WV0005495 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **WV Subtotal** | | **$0** | **$0** | **$0** | **$5,286,279** | **$107,156** | **$559,099** | **$5,736,257** | **$121,229** | **$611,642** |
| **Industrial Total** | | **$0** | **$0** | **$0** | **$50,923,347** | **$3,317,995** | **$7,671,617** | **$97,740,106** | **$7,014,232** | **$15,370,387** |
| **Grand Total** | | **$597,914,959** | **$12,368,080** | **$51,212,168** | **$1,610,367,303** | **$44,415,694** | **$153,455,314** | **$2,847,678,811** | **$94,457,019** | **$285,734,387** |

1. Costs for municipal facilities are annualized at 2.4% for DC, 1.0% for DE, 2.2% for MD, 2.5% for NY, 2.5% for PA, 3.9% for VA, and 0.7% for WV over 20 years. Industrial costs are annualized at 5.76% over 20 years.
2. Includes several State-owned and Federal facilities for which households in the watershed will not incur direct costs.
3. Costs for Blue Plains are for the total facility and will be shared by the States of Maryland and Virginia, and the District of Columbia.

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